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FORMERLY GENERAL SCIENCE QUARTERLY

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Science Education

The Official Organ of the National Association for Research In Science Teaching, the National Council of Supervisors of Elementary Science, and the Science Association of the Middle States

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Science Education

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

Volume 17 OCTOBER, 1933 Number 3

Editorial Notes and Comments

Changes on the Editorial Board

The Editorial Board is pleased to announce that Mr. Clarence M. Pruitt has accepted the office of business manager of the magazine made vacant by the resignation of Mr. Fred G. Anibal who has been elected to a position at Leland Stanford University. Fortunately, Mr. Anibal has consented to represent the journal on the Western coast and will continue on the Board as Western Business Manager. Mr. Pruitt will also remain on the staff as Associate Editor in charge of Abstracts and New Publications. His election to the staff of the School of Education of New York University and his residence in New York makes for a closer contact between the offices of editor, associate editors, and business manager and assures for our readers a better journal.

We are also glad to announce that the Science Association of the Middle States has selected SCIENCE EDUCATION as its official organ and has designated Mr. W. L. Eikenberry of the State Teachers College at Trenton, New Jersey, as its representative on the Editorial Board. The Science Association of the Middle States is an organization of forward-looking teachers and supervisors of science who are making significant contributions to science education. It is believed that the affiliation between the Association and the journal will bring to our readers many excellent papers presented at the meetings of the association and that the journal will be of value to members of the Association.

A Measurement Program in Junior College Science

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The introduction of a new unit in an educational system necessitates the construction of accurate measures if its effectiveness is to be determined. With the inauguration of the Junior College at the University of Minnesota at the beginning of the current year, provision was made under the auspices of the University Committee of Educational Research for a measurement program in a substantial number of the new courses of study. It is the purpose here to describe the procedure in certain courses in science. The courses are three in number: (1) Human Biology, (2) Chemistry and Physics, and (3) Descriptive Astronomy. The first and second are unit courses, three quarters in length; the third is of one quarter's duration. These courses differ somewhat in objectives from the usual type of science course in that they are designed as overview in character rather than as basic to specialized training. As such, the courses cut across some of the usual departmental lines and become somewhat more comprehensive in scope. For example, the first quarter of the course, Human Biology, is devoted to laying a biologic basis through the concepts of the cell, tissues, their growth and differentiation, the development of structure and function with due attention to the mechanism of inheritance with its attendant implications. This content is integrated with the second quarter's work centering in the physiology and anatomy of the human physical machine, followed by a third quarter devoted to personal, family, and public hygiene and preventive medicine. Similarly, the usual discrete classification of physics and chemistry is broken down in the three quarter course, Physics and Chemistry, where the content centers in the broader joint aspects, particularly in reference to the contribution of these fields to the interpretation and understanding of the common environment.

A further characterization of the nature of these courses may be afforded by the statement of the general aim in Human Body, Its Structure and Operation, the second quarter of the course in Human Biology. As given by the instructor the general aim of this course follows: "The diligent pursuit of this course may give to the student a more intelligent concept of what he is and how he behaves—possibly

how he ought to behave. He may sense, if he has some poetry in his makeup and an eye that looks beyond light rays and microscopes—he may sense, at least dimly, something of that incredibly complicated interplay of pygmy forces called life; an activity or process or system of reactions going on in the border region between molecule and mass, a shifting conflict between reduction and oxidation, synthesis and disintegration, fought in a water morass of colloidal aggregates. Yes, possibly the student may glimpse life. But also he may come to comprehend better that simpler, more static, far less complicated thing called death."

From what has been said in the preceding section, it is clear that when a registry of the attainment of course objectives is projected, the task is not a simple one either in theory or in practice. Especially is this the case when one attempts to diverge from the common channels of thought and action. In general, university instructors have not found it expedient either because of other duties or other interests to delve deeply into the details involved in the construction of reliable and valid examinations. A practical method appears to be one that enlists the aid of individuals familiar with the technical aspects of test construction and interested in them. Such individuals are in the main insufficiently versed in the content of the subject matter field. The problem then becomes a coöperative one. The plan of coöperation in the program described here involves the services of a graduate student secured from the subject matter department and upon the recommendation of the instructor in the course. This assistant works in conjunction with the instructor and test technician. The assistant attends the class meetings, makes the basic readings, and analyzes the materials of instruction upon some such basis as (1) technical terms (2) informational facts, and (3) principles. For example, the analysis of the first quarter's content in Human Biology yielded 269 technical terms and 30 biological principles. This provides the major source from which the content of the examination is selected.

An important preliminary step in test construction is a listing of the course objectives. Statements of the objectives in specific terms give direction to the measurement program. These are given for the course, Physics and Chemistry, as:

1. The acquisition of certain physical and chemical facts, principles, and a technical vocabulary (specific knowledge)
2. The ability to employ the scientific method
3. The ability to apply physical and chemical knowledge in the interpretation of everyday experiences
4. Stimulating an attitude of curiosity or inquiry toward the nature of the physical world.

The question then arises whether or not separate tests are necessary for the respective objectives. If through testing one a measure of the others is attainable, the task becomes a much simpler one than if a separate measure is required for each. While the data so far accumulated are of an approximate character, it cannot be safely assumed that the possession of information assures the ability to use it. Since, however, possession is preliminary to use, the measurement of the acquisition of a technical vocabulary, basic facts and principles is always a project of great importance. The measurement of the vocabulary of the student is essential in determining his ability to read basic materials and follow the lectures of the instructor. Knowledge of fundamental facts and principles is a requisite of first rank if thinking is to be effective. This equipment is indispensable for the higher intellectual activities to follow. But functional knowledge needs to be tested as well. It is in the detection of such outcomes that the deeper difficulties lie since the measurement of the possession of information is usually made with ease as compared with the measurement of this knowledge in action. Because the task is a difficult one or because in measuring information it has been assumed that the other outcomes are thereby measured, the development of new techniques, or the application of present techniques, for such purposes has been grossly neglected. It is also likely that on account of the lack of other means, many instructors prefer to use the essay type of examination. Even when the essay type of examination is used, it is unlikely that a check of its validity in terms of course objectives is ordinarily attempted, or that it would attain to any considerable degree of exactness were the check made.

The development of tests of functional knowledge is as intricate as it is important; that is, the construction of measures that will stand the test of validity and reliability. Though some progress has been made, much remains to be done if we are to discover techniques that will serve to produce clarity in a field which at present is in a state of rather puzzling complexity. At least one index of functional knowledge should be the ability of the student to apply the knowledge which he possesses to the scientific solution of problems or new situations. This application of the facts and generalizations of science has constituted one of the major means in the testing program under description. A few illustrations taken from the examinations used in Astronomy, Human Biology, and Physics and Chemistry follow:

Astronomy

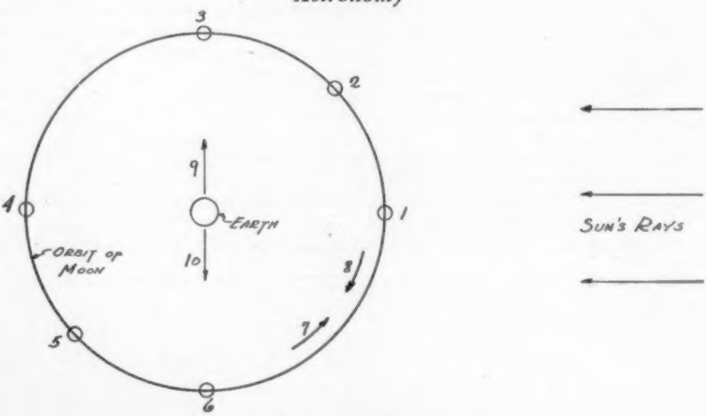

DIAGRAM NO. 1.

In Diagram No. 1 we are looking down from the North.

1. Indicate by the number on the diagram
   a. (1) new moon
   b. (3) 1st quarter
   c. (4) full moon
   d. (2) crescent moon
   e. (7) direction of the moon's motion
   f. (9) direction of the earth's motion
2. At a solar eclipse the moon must be at (1)
3. At a lunar eclipse the moon must be at (4)
4. Draw in the diagram above the shadow of the moon as it is at an annular eclipse
5. Represent in the diagram how a lunar eclipse occurs.

Human Biology

In these exercises the student is asked to select from the list of inferences the one that is the most logical conclusion to be drawn from the recorded facts.

1. A muscle nerve preparation is made by dissecting out the gastrocnemius muscle of a frog with its nerve attached to it. The preparation is put into a suitable holder and the nerve connected to an induction coil. This coil is so set as to allow more than 25 stimulations per second to be sent through the nerve. The current was turned on for ten seconds. Which of the following statements most accurately describes the observed result:
   a. the nerve is stimulated.
   b. an electric current is sent through the nerve.
   c. the contraction resulting from the stimulation is a simple one.
   d. there are magnetic fields set up around the nerve as the impulse passed through.
   e. the Treppe phenomenon is observed.
   f. an impulse passes through the nerve to the muscle.
   g. the resulting contraction is a tetanic one.
   h. the resulting contraction is an isometric one.

2. A muscle nerve preparation is placed on a table. The end of the nerve is dipped in a strong solution of salt. A contraction in the muscle is noted. The nerve is then washed thoroughly and dipped into a drop of glycerine. A contraction occurs as with the salt solution. The nerve is again washed and dipped into a solution of ammonia. Nothing happens. But if the nerve is pinched, the muscle contracts.
   a. different kinds of stimuli cause different kinds of impulses.
   b. ammonia must have poisoned the end plate.
   c. all chemicals can stimulate a nerve and set up a nerve impulse.
   d. there must be some reaction on the nerve by chemicals which causes the contraction.
   e. some chemicals cause a stimulation of a nerve while others do not.
   f. electrical phenomenon must be set up by all chemicals which set up a nerve impulse.
   g. all stimuli act alike regardless of the source.
   h. if nitric acid is used, the muscle would not contract.

Physics and Chemistry

In these exercises the student is given a situation to interpret or a problem to solve, and asked to give his response to a number of statements according to some such directions as: "Examine the statements and classify them, using the letters A, B, and C, which are placed at the left of each statement. Encircle the letter A if the statement is false; encircle the letter B if the statement is true but is of no importance in finding the ANSWER to the QUESTION; encircle the letter C if the statement is true and is useful in finding the ANSWER to the QUESTION."

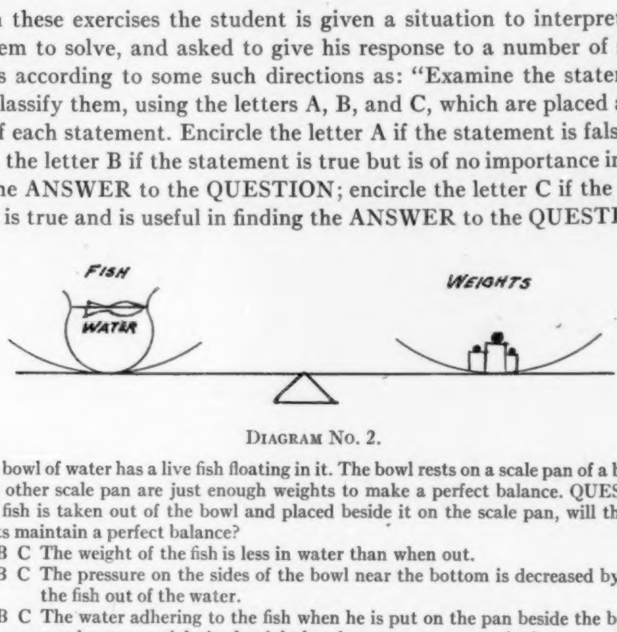

DIAGRAM NO. 2.

A bowl of water has a live fish floating in it. The bowl rests on a scale pan of a balance. In the other scale pan are just enough weights to make a perfect balance. QUESTION: If the fish is taken out of the bowl and placed beside it on the scale pan, will the given weights maintain a perfect balance?

1. A B C The weight of the fish is less in water than when out.
2. A B C The pressure on the sides of the bowl near the bottom is decreased by taking the fish out of the water.
3. A B C The water adhering to the fish when he is put on the pan beside the bowl will require more weight in the right hand pan to compensate for it.
4. A B C The fall in the water level caused by the removal of the fish decreases the downward force on the bottom of the bowl.
5. A B C The water pushes up harder on the fish than the fish pushes down on the water; otherwise he would not float with part of his body out of the water as shown.

ANSWER: The given weights will be ( ) sufficient) to maintain equilibrium.
( ) too large)
( ) too small)

Check the correct item in the parenthesis immediately to the left of it.

It is clear that test items of the above type demand careful evaluation. Among the more obvious considerations are:

(1) The number of test situations necessary to constitute a reliable sampling for determining the ability in question.
(2) The presentation of test situations not previously presented and interpreted in class or as yet incorporated into the materials of instruction.
(3) A determination of whether a knowledge of the particular field is fundamental in detecting the correct inference.
(4) The judgment of scholars in the field as to the validity of the inferences from the standpoint of fact.
(5) The agreement of the results from a controlled response with those from an uncontrolled response.
(6) The differentiating value and validity of the item.

Only illustrations of (5) and (6) will be cited here. In an attempt to determine the extent of agreement between the results from a controlled response and those from an uncontrolled response, the class in Human Biology was divided into two random halves. The same test situations were presented to both groups, but the character of the response called for was alternated in such a manner that one group gave a free response and the other a response controlled to the extent of the selection of the correct from a list of presented inferences. From this analysis, it was found that in one case while 50 per cent of the group whose response was controlled answered correctly only 15 per cent of the group whose response was not controlled gave the correct explanation.

As illustrating the determination of the validity of a test item, the findings of the two test situations given above for Human Biology are cited. It is obvious that a valid item should have a clear-cut solution and that the alternate responses should attract a substantial number of people, more especially the inferior people. The percentage distribution of responses of 150 students to the two test situations follows:

Inference	*Situation 1*	*Situation 2*
a.	10.1	15.3
b.	1.3	12.0
c.	6.7	1.3
d.	1.0	6.7
e.	10.1	58.6
f.	22.9	3.3
g.	45.2	2.7
h.	2.7	0.0

While an outside criterion might be preferable, bi-serial r can be used to afford a basis for determining the differentiating value and difficulty of a test item—bi-serial r obtained on the basis of the respective mean scores on the total tests of the groups passing and failing the test item. Test situation 1 gave a bi-serial r of $.40 \pm .05$; Test situation 2,

.25±06. By such and other means, bases are provided for the improvement of examination items.

Certain phases of the examination program now under way will merely be listed at this time:

1. The development of comprehensive examinations to be given at the conclusion of two years of study.
2. A study of retention over a two-year period, including the relative retention of facts, principles, and the ability to apply principles.
3. A study of the differential abilities of college students.
4. Value of the measures as a basis for the more exact selection of those students with mental reactions essential for the higher types of intellectual pursuits.
5. Development of tests of scientific attitudes and other concomitants.
6. A study of the relative merits of different types of tests.
7. A study of the validity of the test and test items and the difficulty of test items.

With the acquisition of more valid measures, there remains the question of values. Notwithstanding the illusions attendant prediction, it may not be ill-advised to anticipate some of the possibilities of a program of measurement. In this contemplation instructor and student receive reciprocal attention. In the first place more accurate instruments should enable the instructor to evaluate more effectively his materials of instruction and methods of presentation. If the effectiveness of these media can be measured in terms of the achievement of purported objectives, objectives or materials and methods, or both, may yield to modification. It is reasonable to expect that such a policy would elevate the plane both of instruction and intellectual endeavor of student.

It is quite generally held that the character of examinations may exercise considerable influence upon the learning activities of students. If the content is limited to the memoriter type of question, the student is likely to be motivated in mere acquisition of factual information. On the other hand, if it is recognized that the development of powers will be stressed, such as the ability to use and apply knowledge, the student is likely to study with these objectives in mind. Examinations may thus be turned into means for stimulating achievement in terms of functional knowledge. In institutions where such a policy is followed, students have the constant incentive to this type of intellectual action.

More valid measures may also help to subdue regions which at present defy careful scientific investigation. Many of the investigations already effected fail to carry conviction since conclusions have been based upon tests of subject-matter mastery rather than of other functional objectives of the educational process.

Finally, the history of science shows that progress in many of its fields is proportional to the extent to which those fields become more accurately quantitative. This may prove to be true in the case of science instruction as well.

Results of a Three-Year Science Sequence in Junior High School Grades

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The writer has previously presented a study[1] indicating that pupils who took a three-year sequence in general science in the junior-high school grades could be expected to do work in physics and chemistry superior to that of pupils with one year of elementary-biology training. The study also indicated that pupils with general-science training were more interested in science than the others, because of their greater election of science courses in addition to the minimum required for graduation.

The present article is a report of studies made to determine the extent to which, if any, pupils who received five or six semesters of general-science instruction in grades 7, 8, and 9 made greater gains than general science pupils who, for one reason or another, had been forced to omit some of the earlier grades of work. All the pupils involved in the study completed a year of general science in the ninth year. Not all, however, had the full work in the preceding seventh and eighth grades.

The time schedule for science in our junior-high schools calls for two 50-minute periods per week throughout the seventh grade, three 50-minute periods per week throughout the eighth grade, and five 50-minute periods per week throughout the ninth grade. However, some of our senior-high schools receive pupils from the eighth grade of certain elementary schools as ninth-year pupils that have not had the regular junior-high-school program. Such ninth-grade pupils as are considered in this study had no science training below the ninth year and had received general-science training five 50-minute periods per week in the senior-high school.

It has been our custom for some years to make a record of the examination results in physics and chemistry in terms of previous science work taken by each individual pupil. Tables I and II show results of these studies. Attention is called to the fact that the pupils who had completed five or six terms of general science gained higher median scores in chemistry term examinations given in June, 1928, January, 1929, and June, 1929 than did the general-science pupils who had less than five terms of general science. Data are also presented to show that pupils who had taken elementary biology for one year instead of general science had a consistently lower median score than did those with five or six terms of general science. It may be noted, also, that median scores by total general-

TABLE I

CHEMISTRY FIRST SEMESTER EXAMINATION RESULTS AS AFFECTED BY PREVIOUS SCIENCE STUDY

	June, 1928			January, 1929			June, 1929		
	Total Poss. Score	No. of Pupils	Median Scores	Total Poss. Score	No. of Pupils	Median Scores	Total Poss. Score	No. of Pupils	Median Scores
All Chem. Pupils	99	207	60	112	271	71	88	186	59
5 or 6 terms Gen. Sci.	99	114	65	112	143	74	88	104	60
Less than 5 terms Gen. Sci.	99	56	52	112	47	72	88	284	56
Total Gen. Sci. Pupils	99	170	60	112	190	74	88	132	60
Total Ele. Biol. Pupils	99	55	50	112	76	65	88	66	56

TABLE II

PHYSICS FIRST SEMESTER EXAMINATION RESULTS AS AFFECTED BY PREVIOUS SCIENCE STUDY

	June, 1928			January, 1929			June, 1929		
	Total Poss. Score	No. of Pupils	Median Scores	Total Poss. Score	No. of Pupils	Median Scores	Total Poss. Score	No. of Pupils	Median Scores
All Physics Pupils	60	126	46	87	76	56	69	113	50
5 or 6 terms Gen. Sci.	60	59	48	87	41	56	69	4.	54
Less than 5 terms Gen. Sci.	60	28	44	87	9	70	69	37	47
Total Gen. Sci. Pupils	60	87	46	87	50	59	69	77	51
Total Ele. Biol. Pupils	60	32	45	87	26	53	69	25	48
				Monroe and John Marshall					
				68	96	46			
				68	51	49			
				68	22	41			
				68	73	48			
				68	15	39			

science pupils are greater than for total biology pupils, thus, in this respect, bearing out the results stated in the previous study.[1]

Table II shows essentially the same results for students taking physics term examinations in the same years. It should be noted that the physics examination for January, 1929, was different for one school from that for two others. Hence the data are separated.

Table III shows the examination results in ninth-grade general science in June, 1929, as affected by the number of semesters of general science previously studied. Inspection of the data shows that the median scores are consistently higher as the total number of semesters of general science increases.

TABLE III

GENERAL SCIENCE FIRST SEMESTER 9TH GRADE EXAMINATION RESULTS AS AFFECTED BY THE NUMBER OF TERMS OF GENERAL SCIENCE PREVIOUSLY STUDIED

	No. of Pupils	Medians
Total No. 9B Pupils	771	96
No. submitting data	591	
Per cent missing	23.2	
5 terms Gen. Sci.	312	99
4 terms Gen. Sci.	189	94
3 terms Gen. Sci.	73	89
2 terms Gen. Sci.	17	

In June, 1931, a comprehensive test was given to all seventh B and A grades, eighth B and A grades, and 9B grade general-science pupils in the junior-high schools, and to all 9B grades taking general science in the senior-high schools.

The test was prepared by a committee of teachers. It consisted of multiple choice questions, best-answer type questions, and tests involving the use of diagrams, charts, etc. The character of the test is indicated by the following analysis of the possible scores which was printed on the first page of the examination. Objectives to be tested were first set up and then questions were written which were designed to test those objectives.

Under "Directions to Students" the following statements appear:

"This test in science contains many questions, but you will notice that these are grouped around central topics as indicated on your cover sheet. It is not expected that you will be able to answer every question on the test, but every one which you can answer correctly scores a point for you.

"Read each question thoughtfully and decide whether or not you can answer it. If you cannot, pass on to the next one. Eighth-grade pupils should be able to do more than seventh-grade pupils, and ninth-grade pupils

GENERAL SCIENCE TEST

Grades 7B through 9A

Rochester Schools

Check (X) the grades in which you have studied science

7B ...... 7A .... 8B .... 8A .... 9B .... 9A ....

Score	*Total Possible Score*	*Student Score*
Part I. Understanding of Scientific Principles	18	.....
Part II. Appreciation of Great Scientists and of Scientific Ideas of Time and Space		
A. Great Scientists	8	.....
B. Scientific Ideas of Time and Space	6	.....
Part III. The Special Skills of Science		
A. Ability to Use the Scientific Method	3	.....
B. Ability to Observe, to Use Scientific Instruments, and to Report Accurately	7	.....
C. Ability to Interpret Graphs and Diagrams	3	.....
D. Ability to Interpret Scientific Terms	10	.....
E. Ability to Use Reference Material	3	.....
Part IV. Knowledge of Facts of Science		
A. Water	12	.....
B. Earth	14	.....
C. Air	15	.....
D. Fire	6	.....
E. The Heavens	6	.....
F. The Weather	9	.....
G. Energy	16	.....
H. Life	21	.....
I. Micro-organisms	10	.....
Total	167	.....

should be able to do more than eighth-grade pupils. Do not stop too long over questions that you are sure you cannot answer.

"Read the test through to the end as in every section you will probably find some work that you can do."

Following are sample questions to indicate the type:

3. A candle flame will not burn for a long time in a closed jar because
   (a) it gives off water vapor
   (b) it uses up all the nitrogen
   (c) it lacks oxygen
   (d) it gets too hot

11. The study of science should
   (a) make us afraid of everyday happenings
   (b) show us which superstitions to believe and which superstitions to disbelieve

(c) show us that superstitions and fears have no place in our lives
(d) show us that superstitions and fears are necessary in regulating our lives

13. When a cold wide-mouth bottle is placed over a lighted candle, a film of moisture forms on the inside of the bottle. Which of the following facts are you most interested in?

(a) the film of moisture on the bottle
(b) how the film of moisture got on the bottle
(c) how long the film of moisture remained on the bottle
(d) what happened to the flame

19. Great scientists generally

(a) work for selfish reasons
(b) work for money only
(c) require little sleep
(d) are willing to use their discoveries for the common good

20. The world has the radio today because

(a) there are more people than ever before
(b) many scientists coöperated in making it practical
(c) people receive higher wages now than formerly
(d) the radio industry is profitable

27. It is thought by scientists that our earth

(a) has always been as it is today
(b) was formed at the beginning of man's history
(c) was formed a few thousand years ago
(d) was formed countless ages ago

29. The falls in the Niagara River will probably be changed to rapids by erosion

(a) within our lifetime
(b) within the lifetime of our grandchildren
(c) during some sudden spring flood
(d) during the ages to come

34. The best way to determine if hard water makes good soap suds is to

(a) shake soap and soft water together
(b) shake soap and hard water together
(c) find if the laundry uses hard water
(d) try both hard and liquid soaps

35. The following statements are disarranged steps in the report of an experiment. What step represents the application of the principle?

(a) They tied the stone to one pan of the balance, and weighed it. The stone was then allowed to hang in a dish of water and was weighed again
(b) They agree that the stone weighs less in water than in air
(c) One boy now said he understood why he could lift a big stone more easily when it was under water than when it was on the shore
(d) A boy thought that he could lift a stone more easily when it was in water than when it was out of water. Another said "that is not so." So they decided to experiment to find out the facts
(e) Balance; dish of water: string to suspend the stone; weights; stone
(f) The stone weighed 15 pounds in air
(g) The stone weighed 8 pounds in water

40. This drawing* represents a portion of a thermometer tube. The reading would be (a) 63°, (b) 66°, (c) 68°, (d) 90°

41. Which number on the accompanying diagram* represents the height of the mercury in a barometer?

(a) 1, (b) 2, (c) 3, (d) 4.

43. The above is a weather chart* for one week. The air was most humid on

(a) Monday, (b) Wednesday, (c) Friday, (d) Sunday.

44. At 3 P.M. each day for one week the temperature was read and this graph† was made. The temperature was lowest on (a) Monday, (b) Tuesday, (c) Wednesday, (d) Saturday

56. If one wishes to find information about scientists, like Galileo and Torricelli, the most complete account can usually be found in

(a) a textbook
(b) an encyclopedia
(c) a scientific magazine
(d) a book of fiction

67. One characteristic of water which helps distribute digested food in the human body is

(a) its color
(b) its solvent power
(c) its boiling point
(d) its composition of hydrogen and oxygen

92. Evaporation of perspiration cools the body because

(a) heat of the body is required to change a vapor to a liquid
(b) heat of the body is required to change a liquid to a gas
(c) air is usually in motion
(d) warm air is lighter than cold air

101. In order to prevent unnecessary fires

(a) keep all combustible substances from the air
(b) remove one condition necessary for combustion
(c) throw out all combustible substances
(d) keep the air from being heated

105. A needle should be held in a flame for a few seconds before being used to remove a splinter in the finger because

(a) it coats it with soot
(b) it makes the needle so hot that you don't notice the pain from the prick
(c) it kills germs on the needle
(d) it removes any rust from the needle

107. The cause of day and night is

(a) the inclination of the earth's axis
(b) the revolution of the earth around the sun
(c) the rotation of the earth
(d) the length of the earth's orbit

* Drawings are omitted from this report on account of space.

† Graphs are omitted from this report on account of space.

147. Life insurance companies do not favor insuring the life of a person who drinks alcohol because
   (a) he may become intoxicated
   (b) he may not pay for his insurance
   (c) his chances for long life are not good
   (d) he may get in trouble

No claim is made that the questions in each of the several parts actually do test what they are designed to test. However, the questions were designed to accomplish the results indicated. In considering the results by comparison of scores, that is, perhaps, unimportant, providing the test has a reasonable degree of reliability.

TABLE IV
SCORES ON TEST (JUNE, 1931) MADE BY PUPILS IN VARIOUS GRADES

	No. of Pupils	Arith. Mean	Lowest	Highest
7B	621	66.6	15	110
7A	1125	84.7	31	132
8B	906	92.1	28	141
8A	1192	93.9	23	149
9B	919	110.3	61	156
9B+	122	99.7	51	130

Below are tabulated the scores made by 7B and 7A, 8B and 8A, and 9B pupils in the junior-high schools. There appears also in the same table results by 9B+ pupils who had had general science only one-half year, since they had come directly to the senior-high school from the eighth grade of a grammar school. It should be stated, also, that because of crowded conditions of some of our junior-high schools, some 7B pupils are held in the contributing grammar schools. Hence some of the 7A and 8th and 9th grade pupils in these schools missed the 7B work. The percentage, however, is low.

Inspection of Table IV shows a definite increase in arithmetic mean from 7B to 9B, an increase in the lowest score and consistent increases in the highest scores. Attention is called, also, to the fact that the arithmetic mean for 9B pupils, who had had the four previous terms of work in the junior-high school, was 110.3; whereas the 9B+ pupils without this preliminary training had an arithmetic mean of 99.7.

In January, 1932, the same test was given again to all 9B pupils in the city that were taking general science. In the junior-high schools these 9B pupils were the 8A pupils of the previous June. The 9B+ pupils in the senior-high schools were comparable in every respect to the

9B+ pupils in the same schools that had taken the test the previous June. The test was repeated in January, 1932, in order to determine to what extent, if any, the 8A pupils profited by another half year of general science. The data in Table V show that the 1932 9B pupils had an arithmetic mean of 109.7, which compares favorably with 110.3, the arithmetic mean obtained in June, 1931. The arithmetic mean of 109.7 of the January class shows satisfactory improvement over the record of 93.9 made by the same pupils six months previous.

TABLE V

COMPARATIVE RESULTS ON TEST GIVEN AT DIFFERENT PERIODS AND TO DIFFERENT GROUPS

	No. of Pupils	Arith. Mean	Lowest	Highest
8A—June, 1931	1192	93.9	23	149
9B—January, 1932	1430	109.7	42	157
9B+—January, 1932	340	99.5	42	144
College Seniors (Sci. Methods) January, 1932	11	140.2	114	157
Guessing Contest (9th, 11th, and 12th yr. high school, 15 college seniors in Sci. Methods) January, 1932	90	43.3	24	57

Total Possible Score—167

It is interesting to note, also, that the January, 1932, 9B+ pupils who had taken general science only in the senior-high school had an arithmetic mean of 99.5, as compared with the 1931 group of 99.7.

A number of the college seniors enrolled in a science methods course at the University of Rochester were invited to take the test. The arithmetic mean of test scores of this group of students was 140.2. These students had either majored or minored in science in college.

The question was raised by some school people as to whether or not guessing may not have contributed to the results so largely as to invalidate the test. Therefore, the test was copied in code, numbers and letters only taking the place of the printed material of the test. This blank test was then submitted to 90 pupils, including ninth-year science pupils, eleventh-year science pupils, twelfth-year science pupils, and fifteen college seniors referred to above. In the guessing contest the directions were to guess the correct answer and indicate it by checking the desired letter. Table V shows the results of this guessing contest with an arithmetic mean of 43.3, a minimum score of 24 and a high score of 57, the total possible score being 167.

Inspection of the data shows that the lowest score in the 7B grades was 15 with a corresponding highest score of 110. In every grade the highest score was much in excess of the highest score obtained in guessing.

The lowest scores for all pupils range from 15 for 7B pupils to 114 for the college seniors, while the highest scores range from 110 for 7B pupils to 157 for college seniors.

Table VI presents the percentage of correctness of all answers to Parts I, II, and III, as indicated on the score sheet above. These data are available

TABLE VI
PERCENTAGE OF CORRECTNESS OF ANSWERS

	Part I	Part II	Part III
June, 1931			
7B	51.3	56.2	36.9
7A	57.1	60.3	43.2
8B	63.5	71.5	48.1
8A	63.2	73.4	50.0
9B	66.2	73.5	55.3
January, 1932			
9B	66.46	73.82	53.94

only for the junior-high school grades of June, 1931, and January, 1932, since corresponding calculations were not made for the senior-high school 9B + groups.

Inspection of Table VI shows a steady improvement from 7B to 9B grades on each of these three parts. It is interesting to note, further, that the January, 1932, 9B group showed a percentage of correctness almost identical with the 9B group of June, 1931, and further, these data show the same relative amount of improvement from 8A to 9B, as shown above.

As a matter of interest, it may be pointed out that the gain shown in Tables IV and VI of 8A pupils over 8B pupils is not equal to the gain between other consecutive grades. At this date no cause for this flattening of the curve at these levels is assigned.

Tentative Conclusions

While the data presented do not warrant final conclusions, they do present strong evidence in favor of three continuous years of science training in the junior-high-school grades, as compared with one year of either general science or elementary biology, or with less than five semesters of general science.

These data confirm in a significant manner the tentative conclusions cited in the previous article.

The findings from these studies appear to justify certain recommendations made by the Committee sponsoring the *Thirty-first Yearbook,* Part I, "A Program for Science Teaching," namely, "it is recommended that the work of the seventh, eighth, and ninth grades be required . . ." and further, "the sequence and the requirements should be the same, irrespective of whether or not the school system has accepted the junior-high-school organization for grades seven, eight, and nine."

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A Survey of the Present Status of Elementary Science

FLORENCE WELLER *and*
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Nature study and elementary science have great vitality for they continue in their widespread use under many methods, many types of content, and wide variation in training of those who teach. A syllabus in any other field as lacking in generally convincing definition as has been true of this subject would probably have been dropped from the course of study long ago. But the ever ready interest of young people in that which this subject has to offer has provided sufficient force to continue the subject in the curriculum. We think the time is auspicious to focus certain trends to the end that better results may be obtained. It was with this in mind that we undertook the beginning of a survey of the present status of elementary science.

In all pieces of research the method of collecting the data is equally as important as the interpretation of any given data. The method about to be described is a unique account of coöperative research. An ideal way of making a reliable survey of the field of nature study and elementary science would be by inspection of representative types of administrative organization and teaching procedures throughout the country, but this is impractical. As a substitute for this a committee was formed of seven people representing the states of Alabama, California, Colorado, Connecticut, Michigan, Minnesota, New York, and Texas. These states were chosen because they were representative of the different parts of United States. Each of these states was to have one elementary school represented for every 200,000 population, thus giving us by no means a random sampling of schools in the country but a representative sampling of typical elementary schools in the eight representative states. New York City was deliberately left out of this sampling because its system is unusual and so disproportionate in numbers that in such a small sampling it would have relatively too great a weight. The following large cities, however, are represented: Rochester, Buffalo, San Francisco, Los Angeles, Sacramento, Grand Rapids, Detroit, Hartford, Minneapolis, St. Paul, Mobile, and Montgomery. To further insure a representative

* Members of the committee desire to thank Dr. Otis W. Caldwell, Dr. Gerald S. Craig, and Dr. Edwin H. Reeder for their assistance in making this study.

sampling of typical elementary schools we wrote to leading educators in each of the eight states asking them to suggest a given number of typical and representative schools throughout the states. Urban, rural, conventional, and progressive schools, large and small, were to be listed. The executives were not told why these schools were wanted so that a bias, either in favor of, or against, the teaching of nature study and elementary science was avoided. The following is a list of advisory educators and committee members:

Educators Selecting Elementary Schools	*States*	*Survey Committee*
Norma Smith	Alabama	C. M. Pruitt
John A. Hockett	California	Florence Weller
Earl U. Rugg	Colorado	Florence Weller
Fred Camp	Connecticut	Beulah Conover
Jessie McLean	Michigan	Florence Billig
L. J. Bureckner	Minnesota	Jennie Hall
J. C. Morrison	New York	Rose Wyler
W. W. McSpadden	Texas	W. W. McSpadden

The state representatives for the survey were given the list of representative schools in their state and inquiry blanks containing 14 items pertinent to the present status of nature study and elementary science in grades 1 to 6. These blanks were arranged so that in nearly all cases a check or a single word would indicate the desired information. The form was criticized by three research associates at the Institute of School Experimentation, Columbia University. They were then sent out to nine workers in the field who were directly connected with elementary science in some supervisory way. The suggestions made by these people were incorporated in the survey blank and it was then tried out and timed by two special teachers of elementary science and one principal. In this way we had a questionnaire with no superfluous material in it, one that was workable, and one that took only approximately 14 minutes to check. An introductory paragraph similar to the first one of this article was mimeographed at the head of the blank sent to each principal.

The quota of survey blanks was based on the population of each state and in only a few instances complete returns were not available. The quota and number of returns for each state are as follows: Alabama 13—returns 13, California 29—returns 28, Colorado 5—returns 5, Connecticut 9—returns 9, Michigan 24—returns 19, Minnesota 13—returns 13, New York 64—returns 64, Texas 29—returns 21.

In a great many instances the survey blank was mailed to the principal with a personal note explaining why and by whom his school had been chosen to represent the state. In a number of other instances

where the schools were close enough to the state representatives, telephone calls, interviews, or visits to schools were made. It was planned that each representative should have so few selected schools to be responsible for that correspondence between them would be practical. In this way it was thought possible to collect a small amount of reliable data rather than masses of uninterpretable statements. In one instance, where the quota of schools was large the representative secured the assistance of others interested in the field to take small sections of the state and write personal letters to those neighboring principals whose schools had been selected. In some instances incomplete reports were certainly made, but on the whole, we believe much more reliable data were collected than are usually jotted down on an ordinary questionnaire.

When the time limit set for collecting data was up, one member of the committee tabulated it, arranging the tables according to states and sizes of schools, noting practices in small, one- or two-room schools, in medium-sized schools (from 51 to 500), and in large schools (from 501 to 3000). This tabulated material was sent out to all members of the committee, who interpreted and returned it to the committee member doing the tabulation. The following are the results of the study.

In only seven, or 4.1 per cent, of the 172 systems canvassed was there a special teacher of science for grades one to six, in all of these cases the schools had over 500 enrolled. The salaries of these teachers averaged $441 more than that of those teachers teaching all grade subjects, $1886 being the average for special teachers of science and $1445 for grade teachers. The platoon system was used by 6.4 per cent of the schools, 12.2 per cent were semi-departmental, and 15.7 per cent were departmental, for fifth and sixth grades at least. Many had a combination of one of these plans with the conventional plan in the early elementary grades. In the platoon and departmental schools, grade teachers of science taught other subjects also. Nearly three-fourths of the schools (73.2 per cent) had the conventional classroom type of organization where one teacher teaches all academic subjects.

Many types of teaching plans were used, the majority by far (56.8 per cent) using the unit plan. Because of this it was difficult for many principals to estimate the amount of time spent per week in each grade on science, but of those reporting approximations, the average is 72 minutes per week per grade.

A science classroom was reported in 20.4 per cent of the schools and 22.1 per cent have a science museum. Some principals remarked that their museum was small or just beginning so that this statement should be interpreted to mean anything from children's collections to a good-

sized and well-planned museum. These percentages should be particularly gratifying to those interested in the progress of the elementary science movement for it must be remembered that these schools were selected, as nearly as possible, as representative of all types of ordinary elementary school practices, with no mention made of their work in science.

There was a wide divergence among the types of courses of study in use. State courses of study in science were used by 32.1 per cent of the schools reporting for California, and 31.3 per cent of those reporting for New York. Alabama also reports 46.1 per cent using a state course which refers to the general course in all subjects. In a great many cases, local courses or outlines made by supervisors, educators from nearby universities, committees of teachers, *et cetera*, are used, and in 10 per cent of the cases no course at all is used, although it is evident that science is taught in these schools. Whether or not these very local courses are desirable depends entirely upon one's point of view. American educators point toward a continuous and integrated course developed with the aid of specialists since in most cases teachers have neither the time nor the training for this work. English educators think it desirable that each teacher compose her own outline according to her own interests to avoid a bookish attitude of memorizing another subject of study.

In response to an item that asked which devices or methods operated most successfully in their science teaching situation, we received approximately equal numbers of returns on various methods with the project method leading. Reading and discussions were used by 50.0 per cent, experiments by 45.2 per cent, project method by 59.2 per cent, trips by 43.0 per cent, reading and research by 27.3 per cent, and many wrote in pictures and other methods, these lumped together amounted to 8.1 per cent. This shows definite progress away from reading and telling of science stories as the only means of science instruction in the classroom.

In 18.6 per cent of the schools reporting, there was no definite instruction given in science; some of these schools mentioned occasional assemblies or incidental work and others lamented the fact that no definite instruction was given. If we could be sure that only 18.6 per cent of the schools of the country were not teaching science as a regular part of their program it would represent a tremendous gain over preceding years. We can only say, however, that as far as this survey is representative of trends throughout the country this is true.

Another item asked what professional courses were available for teachers in service either at local universities, colleges, normal schools, or by other teachers in the service. Of the schools reporting, 40.0 per cent indicated that some such course was available. It is in this aspect

of elementary science that much needs to be done to strengthen the field. Formal courses need not necessarily be given but personal conferences, group discussions, suggested readings, *et cetera*, with a specialist

SUMMARY OF THE SCIENCE SURVEY OF 172 TYPICAL AND REPRESENTATIVE ELEMENTARY SCHOOLS OF ALABAMA, CALIFORNIA, COLORADO, CONNECTICUT, MICHIGAN, MINNESOTA, NEW YORK, AND TEXAS

	Number of Schools	*Per cent*
1. Type of school.		
Conventional	126	73.2
Special science teacher	7	4.1
Platoon school	11	6.4
Semidepartmental	21	12.2
Departmental	27	15.7
2. Type of teaching plan.		
Hosic's coöperative group	16	9.1
Dalton plan	0	0.0
Winnetka plan	5	2.9
Contract plan	7	4.1
Unit plan	98	56.8
Detroit plan	4	2.3
Individual activity	10	5.8
3. Science classrooms	35	20.4
4. Science museums	38	22.1
5. Professional courses at local universities	58	33.7
6. Professional courses by teachers in the system	12	7.0
7. Special teachers of science (66 in all)		
Courses in subject matter	20	30.3
Courses in science education	11	16.7
Required	10	15.3
Encouraged not required	2	3.0
8. Devices or methods used		
Reading and discussion	86	50.0
Experiments	78	45.2
Projects	102	59.3
Trips	74	43.0
Reading and research	48	27.3
Others	14	8.1
9. Science not regularly taught	32	18.6
10. Number reporting an increase of interest	128	74.4
11. Number reporting no increase of interest	7	4.1

Number teaching science only and average salary	7	$1886
Number teaching science and other subjects	1038	1445
Average number minutes per week per grade devoted to teaching of elementary science	72	

or consultant have been successful in many situations and are suggested by members of the committee.

Of the special teachers of science and those in the platoon schools or departmental systems, in all amounting to 66, 20 (30.3 per cent) are

reported having had courses in subject matter, 11 (16.7 per cent) courses in science education, and in only 10 (15.3 per cent) of the cases are these courses required, while 2 (2.2 per cent) mention that teachers are encouraged to take such courses but it is not demanded of them.

The last item merely asked whether or not there was an increase of interest in the subject. While these data are purely subjective it is interesting to note that 74.4 per cent of the principals checked this "yes," many of them writing in "very much," "decidedly," "markedly" and so on. Only 4.1 per cent checked it "no" and 21.5 per cent left it unchecked; among these were the 18.6 per cent that did not teach science at all.

The Training of High School Science Teachers with a Suggested Curriculum

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The American Association of Teachers' Colleges is urging that more effort be made to raise the standard of work done in the preparation of teachers. In the Carnegie Foundation report of 1927 statements are made which clearly indicate the belief of the committee that science is not well taught in the American high schools and that the teaching of science in the English, French, and German schools is superior to that in the American schools. The reports of committees of Chemical Education, of S. R. Powers, J. O. Frank and others show that there is an extreme lack of uniformity in the curriculum for the preparation of high school teachers in universities and colleges. The training given is not based on the actual needs of the high school teachers. A carefully prepared course of study should be of great aid. In arranging a curriculum for any department one should have in mind its purpose, its major objectives, and the requirements of the schools and the professions.

Surveys[1] show that only about seven per cent of chemistry teachers teach chemistry only. Nearly all teach at least one other subject and most of them teach two or more. The other subjects taught are usually physics, biology, general science, and mathematics. Then, in addition, they often assist with the administration of the school and direct some of the extra-curricular activities. Reports show that few teachers have had adequate college work in all the subjects taught.

Most schools now require high school teachers to have a bachelor's degree and, in order that the high school be on the accredited list of the North Central Association of Colleges and Secondary Schools, the teachers must be graduates of a college belonging to the North Central Association of Colleges and the minimum professional training of any academic subject shall be fifteen semester hours in education. All teachers of academic subjects must teach only in those fields in which they have made adequate preparation. In science, fifteen semester hours of science work is required, five of which must be in the science taught.

At the Integration Conference held at the Michigan State Normal College during the years 1931-1932, the members of the faculty of the

science department, after a critical analysis of the work for which it was responsible and a study of the situation in the state with reference to the actual need of our graduates and the degree to which they are fitting into the work for which we endeavor to prepare them, generally agreed that too few of our graduates were fitted to teach what is actually required of them in the high schools. The student who specializes in chemistry usually takes all the courses he can in chemistry and physics, but none or very few in biology. The specializing student in biology usually loads up his curriculum with biological sciences, one or two courses in chemistry, and no physics.

At a recent meeting of the Michigan College Chemistry Teachers Association held at Ann Arbor, Michigan in December, 1932, the topic for discussion was "The Preparation of High School Chemistry Teachers." The concensus of opinion was that in the curricula usually offered not enough study was given to the other sciences. In many cases no biology, physiology, geology, and very little physics were offered. It was admitted that little thought was given to the actual work required of teachers in the high schools but the courses were planned to give a thorough preparation in chemistry.

"The failure of American schools adequately to teach science is due in part to inadequate training of the teachers. This situation is in direct contrast to that prevailing in Germany and England where science is an integral part of the curriculum."[2] Some teachers colleges are now recognizing this deficiency and are making efforts to overcome it.

Commencing in the fall of 1933, the Michigan State Normal College at Ypsilanti, will present a new science curriculum. All students who elect this course will be required to take as a minimum the following subjects:

	Term hours
General College Chemistry	8
Qualitative Analysis	4
Organic Chemistry	4
Botany	8
Zoölogy	8
Physiology	4
Geology	4
College Physics	12
Astronomy	4
Teacher Training in Science	4

Additional courses in science will be taken according to the choice of the student.

A student specializing in any science may add to the science curriculum enough additional courses to make three or more years in the

science selected. He will not only be well prepared in his major but will have a good knowledge of the other sciences.

The science curriculum presented here in outline form includes all the sciences mentioned above together with the other courses required for a bachelor's degree.

Science Curriculum

Fall Term	*Winter Term*	*Spring Term*
	First Year	
General Chemistry	General Chemistry	Qualitative Analysis*
English	English	English
German or French	German or French	German or French
College Algebra	College Algebra	Trigonometry
Physical Training	Physical training	Physical Training
	Second Year	
Organic Chemistry	Botany or Zoölogy	Botany or Zoölogy
College Physics	College Physics	College Physics
German or French	German or French	German or French
Education (Psychology 1)	Education (Psychology 2)	History or Social Science
	Third Year	
Zoölogy or Botany	Zoölogy or Botany	Physiology
History or Social Science	History or Social Science	History or Social Science
Education (History)	Education (Principles of Teaching)	Science Teaching
Elective	Elective	Elective
	Fourth Year	
Teaching	Teaching	Social Science
Astronomy	Teaching	Elective
Elective	Geology or Genetics	Elective
Elective	Elective	Elective

* If the student is credited with one year of high school chemistry he takes qualitative analysis; if not he takes one year of general chemistry.

If a student takes the course outlined above he will meet the requirements for a bachelor's degree in most universities and teachers colleges in the United States. He will also meet the requirements of the North Central Association of Colleges and Secondary Schools for a teacher of all the following subjects: chemistry, physics, biology, and general science.

It will be noticed that there are nine electives in the third and fourth years so a student could elect enough work to specialize in any one science in addition to taking the science curriculum. It is suggested that the student include in his electives one or two courses in geography and one in speech.

A study of the curriculum will show that it meets the requirements in English, education, foreign language, mathematics, biology, chemistry, physics, history and the social sciences of the North Central Association of Colleges and Secondary Schools, and also the requirements for bachelor's degree in most universities and state teachers colleges.

So far as teaching any science in the high school is concerned, it is not essential to know calculus so it is not included in the curriculum. However, if a student cares to specialize in chemistry or physics and likes mathematics he could well take three of the electives in advanced mathematics.

In the Thirty-First Yearbook of the National Society for the Study of Education, Part I, S. R. Powers,[3] reporting on the education for science teachers, says in the summary: "The typical offering in science in normal schools and state teachers colleges consists of relatively few courses, uniquely named, with a decided tendency to make each course a unit unto itself, with few or no prerequisites, and with little or no recognition of sequence between courses.... The committee recognizes the need for breadth and for thoroughness of training and clearly recognizes the need of sequence."

In the curriculum presented it will be noted that some thought has been given to sequence and some effort has been made to correct the typical offering in science in teachers colleges.

The curriculum presented is only suggestive and ought to be helpful in classifying students in science. The preparation of the student and his choice of electives will vary the arrangement.

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The Place of the Field Lesson in the Training of Teachers of Elementary Science*

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This paper is a brief summary of the convictions acquired through more than twenty-five years of experience in individual field study and in field teaching of teachers and prospective teachers in elementary science. In addition, it has been my rare good fortune, through membership in the *St. Louis Nature Study Society*, to have teachers, supervisors and administrators of many types of schools, public and private, study with me in the field for periods varying from one to fifteen years. For me, as a teacher of actual and prospective teachers of elementary science, the classroom, the laboratory, and the library have come to be chiefly valuable accessories in preparing for field lessons, in interpreting observations made, and in solving problems encountered in the field.

Because of the brevity of the paper, some of the statements may appear dogmatic. They are not so intended. I am still a learner in this field and I am willing to change any view expressed here whenever the conclusions of future study make it desirable to do so.

A field lesson as used in this paper is the development of any learning unit outside of the classroom or laboratory by a group of pupils under teacher guidance. It may take place on the school-ground or on a vacant lot, on the street or on the roadside, in the park, private or public, or in the garden, school or home, in some commercial establishment or in a factory, in a museum or in a quarry, in the woods or in the open field, in the ravine or in the canyon, on the banks of a stream or at the edge of a pond, in a swamp or in sphagnum bog. The lesson may require ten minutes or a class period, or a half day, or an evening. Trips longer than a day have value if there is considerable flexibility in the schedule outlining the activities. Such trips also may be broken into parts each of which has its own goal. Unless a detailed syllabus stating the plan and aim of each part is in the hands of each student, and is faithfully followed, there is likely to be a waste of time resulting in the wrong attitudes towards field study.

Aims of Elementary Science

It is assumed that the field lesson is an important part of the science curriculum in the elementary school. Therefore, its purposes must help

* Read at the Atlantic City meeting of The American Nature Study Society, December 27, 1932.

to realize the more general aims of elementary science which, in my opinion, may be stated as follows:

1. An acquaintance with many facts in nature through direct and indirect observations. Direct observation here means sense perception through sight, smell, touch, taste, hearing, and muscular sense.

2. Some ability in investigation and experimentation through understanding the techniques of problem-solving in science and through practice in these techniques.

3. Out of trained observation and problem-solving ability, an understanding and an appreciation of the relationships and adjustments found in nature apart from man and of the numerous relationships man may sustain towards nature.

4. In general "an equipment that will make the child want to go out into the vast home of nature for enjoyment, recreation and investigation, and conversely when he returns from outdoors. This same enjoyment should make him want to know more of the literature of outdoors, both informational and inspirational in character."

5. As an outcome of the previous aims such a meaning of certain moral and social values as will compel certain types of conduct through knowledge and appreciation rather than through fear and suspicion.

Aims of Elementary Science in Teacher Training

In brief, these aims may be said to be those of science in the elementary school realized in a learning situation different from that in the elementary school and with materials suitable to the needs of the students plus an understanding and an appreciation of the field lesson acquired through a study of the technique employed and much learning experience in the field. The first responsibility of teacher-training institutions is to see to it that their students have a more adequate grasp of the subject matter which they expect to teach. In the training class in elementary science this probably can be accomplished by professionalizing the subject matter of elementary-school science and by providing for a closer integration of the field lesson with the classroom work both prior and subsequent to the field lesson.

How the Field Lesson Can Help to Professionalize Elementary Science

The richest source of materials to be used in observation, in experimentation and in problem solving is the field as defined in this paper, not the library or the laboratory or the classroom, however useful all three may be. Experience getting, experience interpreting, and applying the results of interpretation in getting other new experiences and modifying old ones are the heart of science education if not of all education.

Unusual emphasis at this time needs to be given to the field lesson because students coming to the training school for the most part have a superficial, if not wholly erroneous, view of the nature and purpose of extra-mural activities as learning instruments in science and also because of the changing concept of the nature and importance of science to elementary-school children along the line of integrating school and life more completely.

The Nature of the Field Lesson for Teachers and Prospective Teachers

Appropriate assignments for library investigation and class discussion should precede the field lesson so as to set forth in an adequate manner the need for such study. After a preliminary study of the field to be covered the teacher should prepare a detailed outline of the lesson and should place a copy of such outline with each student long enough prior to the trip so that the class may become definitely familiar with the language, purposes and procedures. Different outlines would be required for the study of a white oak tree in April or early May and for the study of the same tree in September or October. However, the same outline on a certain quarry may properly be used in April and in October. In other words, specific trips require specific outlines.

Such an outline should become the basis of the work in the field. If the outline is well planned and written in sufficient detail it can be used for individual or group study and for individual or group instruction. In such a case the teacher becomes a supervisor of learning.

A summary of the important points covered should be made by the students under teacher guidance before leaving the field. This furnishes an opportunity to reveal how much and how little has been accomplished by different members of the group and to correct gross errors in observations or in interpretation. The outline can also be used in a self check-up exercise before leaving the field.

In my present practice the matter of field notes is left largely to the students because I am dealing with mature individuals for the most part. Those who are not mature, soon become so or drop the course. The amount and high character of work my students do in connection with our field lessons is a source of gratification to me. I find that those students who seemingly benefit most in the field contribute much local field material for laboratory study. After a given field lesson it is my practice to provide opportunity in several recitations to use field experiences.

Students should expect to be held responsible for the field lesson in the same manner that they are held for laboratory and classroom studies and recitations. In short, the field lesson should be regarded as an

integrating factor between library and laboratory in the training of teachers of elementary science.

Elementary science is at its best for old and young when there is constant interplay between the field on the one hand and the library, laboratory, and classroom activities on the other. The field should drive the student to library and laboratory and should provide stimulating classroom recitations before and after. If the use of the library and textbook and laboratory encourages field study and aids in verifying observations made, also in solving problems encountered in the field, then test and library and laboratory have a proper place in training teachers of elementary science. A course in educational biology is not an acceptable substitute for a course in the teaching of elementary science. Often it is a poor preparation for it. In my opinion, some texts in educational biology are doing more harm than good because they largely neglect the field and often overlook opportunities for good laboratory work.

School lessons in the teaching of elementary science can become educative only as they tie up with field studies before and after. If this is done young teachers leaving the training school will carry with them a type or preparation for teaching elementary science to children now rarely found in our schools.

The Value of Field Lessons to Teachers in Training

1. Field lessons broaden points of view and motivate reading and further investigations.

2. Field lessons afford opportunity for learning in a more natural and informal setting than is afforded by ordinary classroom conditions.

3. They make it possible to acquire a background of out-of-schoolroom knowledge of science hitherto largely neglected. Many young people entering our teacher-training courses are unfortunate products of inadequate science training in both elementary and high school.

4. Field lessons provide a fine type of training in the management of extra-mural groups in a natural social setting.

5. The young teacher who has had good training in proper field lessons is better prepared to guide the work of children in the classroom.

6. Field study leads to keen and purposeful sense perception and to better interpretation through the aroused need of answering questions by problem-solving methods.

7. Field study gives new zest and meaning to library, laboratory and classroom work.

8. Lastly, the field lesson, as defined in this paper, if it is supervised and conducted by properly equipped individuals, is a very effective and enjoyable instrument for group teaching.

Results of Testing Laboratory Instruction

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The Objectives

The following laboratory experiments are provided to develop (1) exactness in measurement, (2) ability to apply knowledge, (3) ability to devise laboratory procedures and (4) ability to complete the devised procedures.

This type of laboratory work emphasizes perceptual or direct experience which is a type of learning not stressed in education in proportion to its necessity in after life.

The Exercises

The initial exercises should be motivating and should produce satisfaction with accurate, and dissatisfaction with inaccurate measurements. They should create a desire for exactness and give practice in making actual measurements which must be exact. Introductions are offered to motivate or create the desire. The first four exercises do not attempt to develop scientific principles.

Exercise 4

Object. To show the necessity of accuracy in practical work.

Apparatus. Protractor and rule.

Introduction. In case of land surveys, much trouble has resulted from inaccurate work. Most cities have had or are having lawsuits over the extent and exact location of a certain piece of property. In the case of a railroad suit the only record shown on the survey named the point from which all measurements were taken, as, "the large oak tree where we shot a deer." A mistake of six inches along the side of a one-hundred and fifty foot lot means a mistake of ½ by 150 or 75 square feet. City lots run from ten cents to one hundred dollars or more per square foot showing that the error might be one of some moment. Cases where buildings have been built extending to other owners' ground have not infrequently caused lawsuits and expensive changes. These troubles are due to carelessness and inaccuracy that could easily have been avoided.

Directions. On laying out some city lots the engineer finds upon making a survey that the streets are not at right angles but that at the corner where he is standing the angle made by the streets is 91 degrees. If the opposite streets on the side of the plot of ground are parallel, draw the plot 700 ft. on each side, scale 50 ft. to the cm. on cross section paper or the back of the preceding exercise; if it is not accurate no credit will be given. Suppose the engineer had assumed the streets to be at right angles and had run his line at right angles rather than at 91 degrees.

How far would he have missed the corner points?. . . . .

Exercise 5 introduces density along with the manipulation of the beam balance. Text references to density are provided and the texts made available in the laboratory.

Exercise 6 is a self-testing exercise. With the instruments of the earlier exercises, the pupils are provided a check on their accuracy of measurement. This is not a test for obtaining a mark in the course but a test for the pupil to apply to himself for his own satisfaction. Accuracy and not speed is stressed.

Test Exercise 6

Measurement

Object. That you may test your ability to use measuring instruments.

Apparatus. Scaled rule, protractor, micrometer, vernier, and platform balance.

Introduction. The necessity of accuracy in measurement has been pointed out in the preceding exercises. You can convince yourself and others of your ability by actual results only. The following measurements are so arranged that there is some method of checking the results. An appreciable error means inaccuracy. Find your weak points and overcome them.

1. Scaled rule

Draw a triangle on the back of the last sheet with side AB, 10 in. in length. Measure the side *AB* of triangle *ABC* with both English and metric scales.

	1st trial	2nd trial
(a) Length in inches	....	....
(b) Length in centimeters	....	....
(b) divided by (a)	....	....

2. Protractor. Measure the angles *A*, *B*, and *C* of triangle *ABC* and mark on the figure.

	1st trial	2nd trial
Sum of angles	....	....
Sum should be	....	....
Per cent of error	....	....

	1st trial	2nd trial
3. Micrometer		
(a) Measure the thickness of ten sheets of your text	....	....
(b) Measure thickness of twenty sheets of your text	....	....
(c) Twice measurement (a)	....	....
(d) Difference (b) and (c)	....	....
(Paper may vary .01)		

	1st trial	2nd trial
4. Vernier		
(a) Measure thickness of twenty sheets	....	....
(b) Measure thickness of fifty sheets	....	....
(c) Two and a half times (a) is	....	....
(d) Difference (b) and (c)	....	....
Per cent of difference	....	....

	1st trial	2nd trial
5. Weighing		
(a) Weigh a 25 cc. sp. gr. bottle (dry)	....	....
(b) Weigh bottle filled with distilled water	....	....
Subtract (b) − (a)	....	....
Room temperature	....	....
25 cc. of water at room temp. should weigh	....	....
Difference	....	....
Per cent of error	....	....

Exercises 7, 8, 9, 10, 11, and 12 present various methods of measuring density and specific gravity. These are accompanied by appropriate text references and are varied to require thorough adaptation to both density and specific gravity. Motivating introductions are still included and the same materials are used in different exercises to provide further data upon accuracy. Exercise 12 introduces another measuring instrument which requires accuracy in use.

Exercise 10

Object. To find the specific gravity of an unknown liquid.

Apparatus. Specific gravity bottle, balance, weights, and unknown liquid.

Introduction. In testing alcohol, gasoline, and various liquids the sp.gr. is a mark of the condition of purity. Each different liquid has its definite sp.gr. and can be distinguished from others accordingly. The sp.gr. of an oil gives an idea of its lubricating qualities. For exact sp.gr. determinations, the sp.gr. bottle is used.

Directions. Weigh the sp.gr. bottle carefully when dry and clean. Fill the bottle with distilled water at room temperature. Wipe the outside carefully and reweigh. Now empty the bottle and rinse well with the liquid whose sp.gr. you are going to determine. Fill with this liquid and reweigh with every precaution. Empty the unknown liquid back into the container. After making your computation consult a sp.gr. table and find what the unknown liquid is .... If undecided complete exercise 11, before offering an answer.

Wt. of sp.gr. bottle empty ....Wt. of sp.gr. bottle and liquid..............
Wt. of sp.gr. bottle and water............Wt. of unknown liquid......................
Wt. of water...........................Sp. gr. of unknown liquid...................
Specific gravity is the ratio between the weight of a volume of the liquid and the weight of an...

Exercise 11

Object. To find the specific gravity of a liquid.

Apparatus. Balance, glass stopper, and some of the same liquid used in previous experiment.

Introduction. A second method of making any laboratory determination furnishes a check upon the exactness of the previous procedure. The following exercise provides a second measure of the specific gravity of the liquid used in exercise 10.

Directions. Suspend the stopper from the beam of a sensitive balance by means of a light thread so it will hang entirely beneath the surface of the distilled water in a beaker. Determine the stopper's weight in water. In the same manner, determine its weight in the liquid whose specific gravity is being sought. What is the weight of the stopper in air? Now record the loss of weight in water and in the liquid. How is the specific gravity found by the "loss of weight" method?..
....
....
....
....

Observations	Results	Calculations	Results
Wt. of solid in air		Loss in water	
Wt. of solid in water		Loss in liquid	

Wt. of solid in .... Sp.gr. of ....

....

If results in these two experiments differ, offer your explanation..................

....

....

....

....

Exercises 13, 14, and 15 are test exercises which give the pupils a chance (1) to test their abilities to apply knowledge, (2) to devise their own procedures, and (3) to prove the applicabilities of these procedures by carrying out the experiment according to the devised method. The apparatus provided requires a different procedure from any used in previous exercises and insures the same general knowledge of density and specific gravity and accompanying accuracy of measurements.

Experiment 13. Test Exercise

Object. To apply your knowledge and ingenuity in making a specific gravity determination.

Apparatus. Vessel graduated in centimeters; appropriate sized weight of which the specific gravity is to be found.

Introduction. Life problems are laboratory problems. The apparatus on hand must often be fitted to the needs. A knowledge of your work is absolutely necessary. If you now understand specific gravity as one should after the preceding exercise, you can fill out by steps your procedure and results in solving this problem.

Procedure. 1. ....

....

2. ....

....

3. ....

....

Numerical data from procedures.

1. ....

2. ....

3. ....

Computations.

4. Specific Gravity ....

While exercises 13, 14, and 15 are presented to pupils in order to test the abilities designated, they are not used to obtain school marks. Some pupils complete this unit before others, and exercise 15 is another form of the test exercise to be used when results from exercises 13 and 14 show the need of repetitions of former exercises and a later test. All three exercises were given to groups considered in this study.

PHYSICS PROBLEM. FINAL TEST NO. 2

Object: Find specific gravity of a given liquid.
Apparatus. Given 1. 5 cm. wooden cube.
2. weight
3. liquid to find sp. gr. of
4. spring balance

Procedure. 1. ....
....
2. ....
....
3. ....
....

Numerical data from procedures.
1. ....
2. ....
3. ....

Computations.

Answer ....

The Tests

An example of the final tests which were used to obtain a rating of achievement in the abilities offered as the objectives of the unit is presented above. A deficiency is quite apparent since exactness is measured only when the ability to devise and carry out the procedure has been achieved. The tests are not entirely diagnostic, although the measure of exactness can be separated from the rating of achievement in other abilities, since exactness is not necessary to the devising or carrying out of the procedure. Dynamic knowledge is necessary if the pupil is to devise the correct steps, and an exact answer in most cases shows the desired achievement of all objectives. Any answer arrived at by appropriate steps offers a single objective rating for several features: mastery of the concept of density, and of specific gravity, and the abilities to devise and carry out the procedures for measuring density and specific gravity. A standard for rating achievement of accuracy in measurement must be provided. An answer which is accurate in that it is within the limit of probable error provided by the instruments can be taken as satisfactory, while any other answer shows the need of stressing accuracy in further units for the individuals exhibiting deficiency in exactness of measurement. In the fifty cases used, accuracy was scored by subtracting the per cent of error, over and above the per cent of error of the instruments used, from 100 per cent. If the per cent of error was 100 or greater, the score was zero. In considering accuracy, the recorded meas-

urements and not the final answers were used in order to eliminate errors in the fundamental processes of arithmetic. The objective was accuracy in measurement. Scores of accuracy were thus obtained from (1) the final tests, (2) test exercises 13, 14, 15, and (3) self-testing exercise 6. Therefore, two scores are obtained from the final test and test exercises 13, 14, and 15. One score is a rating of accuracy and the other a combined rating of the knowledge of density, knowledge of specific gravity, and the abilities to devise and carry out the procedures for measuring density and specific gravity.

The content test (5) included definitions of density and specific gravity, three problems on density and three on specific gravity similar to those required by the laboratory exercises, request for the data or measurements necessary to determine (a) density and (b) specific gravity, and a request for an explanation of the numerical equality of specific gravity and density when metric units were used in the required measurements.

Implications of Correlation Coefficients

The zero-order correlation coefficients shown in Table I reveal certain significant findings from this study. The relationship between intelligence scores and scores from the content test $r_{45} = .49$, does not offer any significant difference when compared with the relationship between intelligence scores and scores from the laboratory tests of ability to devise and carry out procedures as presented by the correlation coefficients, $r_{46} = .53$ and $r_{47} = .38$. The means of the group upon the content test and laboratory test were 63 and 61 respectively.

TABLE I

ZERO-ORDER CORRELATION COEFFICIENTS USING THE PRODUCT-MOMENT PROCEDURE

r_{12}	r_{13}	r_{14}	r_{15}	r_{16}	r_{17}	r_{23}
$.63 \pm .61$	$.45 \pm .076$	$.07 \pm .094$	$.01 \pm .095$	$.66 \pm .055$	$.54 \pm .066$	$.60 \pm .061$
r_{24}	r_{25}	r_{26}	r_{27}	r_{34}	r_{35}	r_{36}
$.23 \pm .092$	$.07 \pm .094$	$.64 \pm .055$	$.87 \pm .023$	$.14 \pm .093$	$.06 \pm .095$	$.53 \pm .65$
r_{37}	r_{45}	r_{46}	r_{47}	r_{56}	r_{57}	r_{67}
$.44 \pm .078$	$.49 \pm .072$	$.53 \pm .067$	$.38 \pm .083$	$.20 \pm .092$	$.25 \pm .089$	$.80 \pm .034$

1 represents scores of exactness from final tests.
2 represents scores of exactness from exercises 13–14–15.
3 represents scores of exactness from exercise 6.
4 represents intelligence scores.
5 represents scores from content test.
6 represents scores from final test, omitting rating of accuracy.
7 represents scores from exercises 13–14–15, omitting rating accuracy.

Little relationship appears between exactness and intelligence. The correlation coefficients between intelligence scores and the three sets of scores of exactness are $r_{14}=.07$, $r_{24}=.23$, and $r_{34}=.14$. This relationship is least, or practically disappears, in the final test's scores of exactness where time did not permit checking or intelligent re-considerations of answers.

There is no relationship between scores of exactness and scores of knowledge of content, $r_{15}=-.01$, $r_{25}=.07$, and $r_{35}=.06$. The agreement of these correlation coefficients emphasizes this lack of relationship.

Considering the fact that there was a chance for further learning from exercises 13, 14, and 15, the coefficient of correlation, $r_{67}=.80$, between the abilities to devise and carry out procedures as scored from (a) exercises 13, 14, and 15 and from (b) the final tests shows a satisfactory measurement of like objectives by these similar tests. A like statement can be made concerning the scores of exactness from the same tests. One cannot overlook the fact that pupils' scores of exactness from the two laboratory situations (self-testing exercise 6 and exercises 13, 14, and 15) give a higher correlation, $r_{23}=.60$, than do the scores of exactness from the self-testing exercise and the final test, $r_{13}=.45$. This may be due to changes in figures obtained on the self-testing exercise when the checking devices showed errors, or to some difference in the measurements of the different exercises. Erasures on exercise 6 would favor the former explanation.

The correlation coefficients between the scores from the content test and the scores from tests of ability to devise and carry out procedures, $r_{56}=.20$ and $r_{57}=.25$, show little relationship between knowledge of content and the procedure abilities.

Conclusion

The laboratory offers an ideal situation for training by direct experiencing. Tests by laboratory procedure offer direct measures of (1) exactness of measurement, (2) ability to apply knowledge, (3) ability to devise procedures, and (4) ability to complete the divised procedures. Correlation coefficients point to the slight relationship between the abilities named and the ability to answer questions upon the text content concerning the principles involved. The laboratory is, therefore, indispensable to teaching based upon any broad recognition of objectives.

A Technique for the Discovery of Working Objectives in Science

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In the pages which follow, the work of the senior author has been largely suggestive and directive while the credit for the working out of the technique should be given to the junior author.

Aims clearly set up, and objectives specifically defined, are foremost functions of any curriculum. There are certain definite values which are supposed to result from the study of secondary-school science. If these values are ever to be realized, teachers of science must know exactly at what they are aiming. Long lists of science objectives have been worked out as a result of many studies. The studies of Barber,[1] Klopp,[2] Tildsley,[3] Bergen and others,[4] and Hunter and Knapp[5] furnish representative lists. While much emphasis should be placed on such studies and on the resulting lists of science objectives, yet the mere listing of great numbers of objectives, without proper analysis to show where each fits into the educational scheme, has a tendency to "blanket many teachers with a metaphysical fog."[6]

Current educational literature contains many expressions of regret that science teachers fail to accomplish the objectives which have been set up. When Hopkins said, "To have a vague aim in a subject is of no greater value than having no air,"[7] it seems that he suggested one cause of the above mentioned failure. Objectives are worthless unless they can be made to function in the class room. Every listed aim of science may be a worthy one, yet the list as a whole may be very confusing unless the various objectives are properly classified, each seen in its proper place, each perceived in its correct relation to the whole, and some certain one singled out as applicable for use at a certain place and time. If science teaching is to become more effective, the prime need is not for more and longer lists of objectives, but for more careful analysis of the lists which we already have, in order to show the relationship which exists between any one objective and the whole list, and also to show how the immediate objectives work together to accomplish the ultimate aims of all education.

The list of science objectives found in a study made by the writers[5] is very comprehensive and representative. This list is used as the basis for the following analysis, which is offered mainly to suggest a technique which may be used on any long list of objectives.

Step Number One

Eliminate from the list all of those objectives which are merely repetitions of the ultimate goals of all secondary education.

Following the above instructions one would eliminate the following: —"Worthy use of leisure," "Citizenship," "Ethical character," "Cultural," and "Worthy home membership." These would be eliminated because they have no place in the realm of immediate objectives. They are the ultimate goals of all secondary education, and are already listed in the "Seven Cardinal Principles" or in one of the other similar classifications of ultimate aims. These ultimate goals are too all-embracing to be accomplished by any daily lesson, by any unit, or by any special subject. They are the final results which come from adequately accomplishing many properly correlated but more immediate objectives.

Step Number Two

Group together those objectives which are really accomplished more through proper methods of teaching than through direct attack.

To the writers it seems that this grouping would include, "To arouse interest in science," "To keep alive childhood curiosity," and "To give basic science experiences." These objectives are grouped together, not to be eliminated, but rather to be thought of as by-products of proper teaching methods. It seems that they can best be accomplished by proper lesson planning and by the methods used in class. All three aims are vital factors, yet when the teacher sees them in the above perspective, it makes it more possible for him to blend them into his program in an effective way.

Step Number Three

Group together those aims which are the means to an end rather than an end in themselves.

Factual knowledges should be thought of as tools, used as a means of building up proper understandings, appreciations, skills, concepts, and attitudes, rather than as materials to be accumulated. In writing of the student, Morrison[8] has the following to say, "If he (the pupil) later needs the factual information, it is a simple matter to look it up. As a matter of fact, however, full and actual understanding proves to be a powerful mnemonic, for it is apt to carry along with it the important facts which were encountered in the achievement of the large understanding." It is with the above idea in mind that the writers have grouped the following objectives as means to an end rather than ends in themselves:—"Propaedeutic functions" (mainly factual material) and "To give information."

Step Number Four

Of those remaining objectives in the list, eliminate any which may be felt to have no place as a real objective.

In carrying out this step the writers would eliminate the aim, "To develop powers of observation, reasoning, *et cetera*. There is a strong tinge of faculty psychology in the way this objective is expressed. When a child is interested in a certain thing he will naturally observe it. The prime thing is to build understandings, appreciations, and interests in the environment, and observation will naturally follow. As far as developing a faculty of observation of anything and everything, there is much doubt about that ever being accomplished.

Step Number Five

Classify the remaining objectives into closely related groups. Six classifications have been made, each group having an arbitrary caption which seems inclusive enough to take in everything in the group.

A. The discovery and development of desirable habits of study.
  - To develop desirable study habits.
  - To develop a fact finding technique.
  - To master the scientific method of problem solving.
  - To establish scientific thinking habits.
  - To develop a scientific attitude toward all problems.

B. The development of one's ability to utilize his environment to the highest possible degree.
  - To help pupil understand his environment.
  - To impart knowledge about one's environment.
  - To arouse interest in one's environment.
  - To develop attitudes of appreciation of one's environment.

C. The development of an attitude of appreciation of the scientific basis for personal and racial health.
  - To develop an appreciation of the value of health.
  - Sex education.

D. Exploration.
  - To explore the field of science.
  - To explore the pupil's interests.

E. To develop an appreciation of the work of scientists.
  - To humanize science and science teaching.

F. The development of skills in doing such tasks as are most likely to be needed in life.

A classification similar to the above tends to focus several of the similar objectives on larger and more fundamental aims, thus decreasing the number of generalizations to be held in the teacher's mind.

Step Number Six

Organize the above classifications into some system such that one can see the relationship which exists between the parts and the whole.

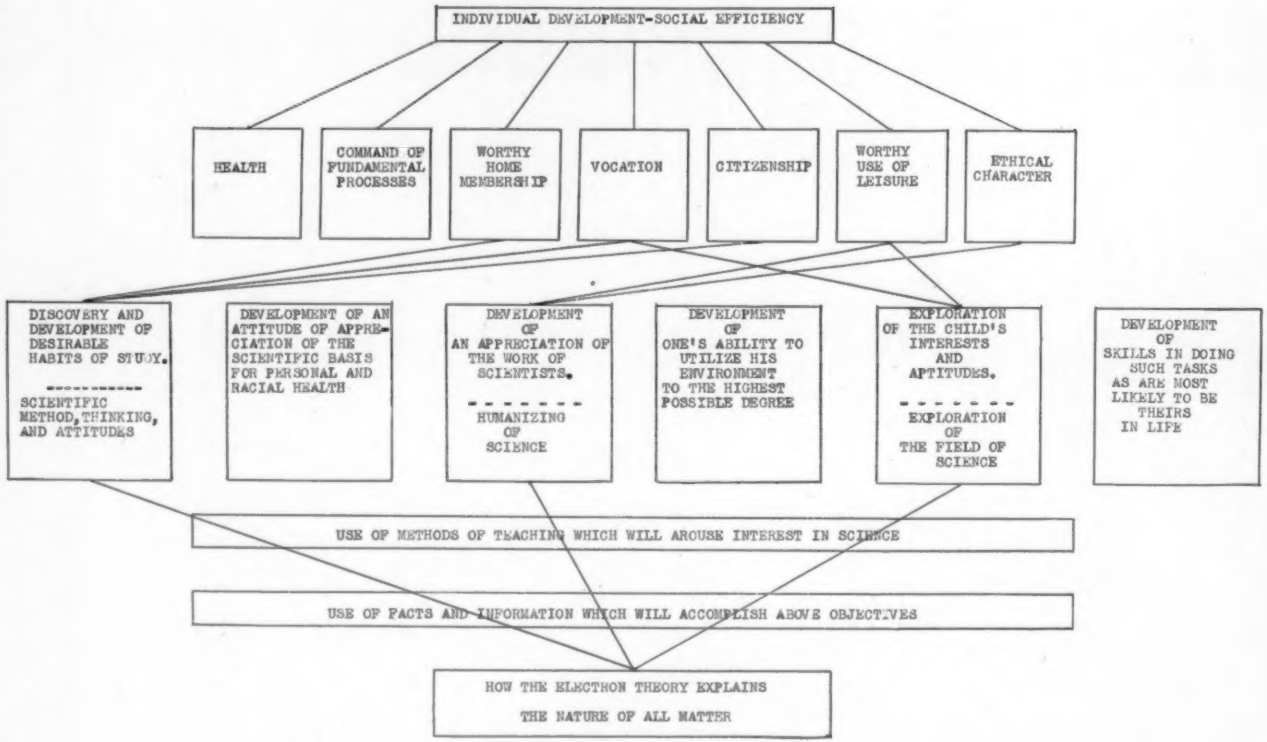

FIGURE 1. CLASSIFICATION OF OBJECTIVES OF SCIENCE.

The chart shown in Figure 1 is a graphic illustration of the organization which might be made of the classifications mentioned above. At the top of the chart is first set the ultimate goal of all education in accordance with the conception of Douglass[9] who says, "In this country, the chief educational ends finding acceptance have been, and are, individual development and social efficiency." At the next lower level, and set on a horizontal line are listed the ultimate aims which work together to accomplish individual development and social efficiency.[10] For this diagramatic illustration the "Seven Cardinal Principles" are used, but any similar list such as Spencer's, Peter's, Bobbitt's, Snedden's, Monroe-Weber's or others could be substituted with little different results.

While the ultimate goal of all education and the ultimate aims leading to that goal are vital, yet it is generally recognized that little is accomplished by these aims alone. Douglass[10] has well expressed this idea. He says, "To aim in instruction at social efficiency in general, or even at one of the more definite objectives (as command of the fundamental processes), is to shoot blunderbuss fashion. The objectives of secondary education must be subdivided and analyzed in detail before they can exert the influence they must exert either in curriculum building or in teaching." Monroe[11] expresses the same idea. He says that phrases as "ethical character," "health" . . . and "citizenship" do not express concepts that the high school teacher is able to apply directly in deciding what learning exercises he should ask his students to do. Uhl[12] also agrees with the above authorities, for he says, "These principles (cardinal principles) were largely names of values, and consequently they could not become causes of action until they were given motive power by associations with forces which lead to action." Colvin[13] expresses the idea in still another way when he says, "The aim before the teacher, which determines the method that is to be employed in each specific lesson, must be related to the 'higher' proximate aims and to the ultimate aim, but they cannot be substituted for it. The aim which serves as the direct point of attack must be immediate and relatively simple."

It is in accordance with the principle so well expressed by the above cited references that the third level of objectives appears on the chart. The objectives of this level are taken from the classification made under step number five of the procedure explained earlier in this paper. These objectives express the outstanding attitudes, habits, controls, concepts, and skills which science is particularly well adapted to develop.

To illustrate how such an organization may function, a possible unit of study is listed at the bottom of the chart. In the words of Morris-

son[8] the unit must be, "... some significant and comprehensive part or aspect of the environment or of the science which is being studied." Assuming the unit used for this illustration to be a good one, the teacher must choose various problems needed in the development of this unit. If the generalization is properly developed so that mastery results for the pupils, those pupils have "acquired a new attitude toward the world in which they live."[14] Inasmuch as the unit should contribute to the exploration of the pupil's interests, help him understand the use of the scientific method, and develop an appreciation of the work of scientists, it may be deemed a worthy unit to use in science, especially physics. To develop the unit of work, and have the desired attitudes acquired, the teacher must use methods which will create interest in science, keep alive childhood curiosity, and give basic experience. The teacher must also use subject matter, not as an end in itself, but as a means of developing the unitary idea, and the desired attitudes for which the unit was chosen. In the chart these necessities are graphically portrayed by two separate fields through which any line must pass when drawn from the unit objective to the science objective above. Thus the idea is conveyed that the teacher cannot get from his unit objective to the science objectives and the ultimate aims above without going through a field of subject matter and factual material, and also through a field of proper methods. These fields cannot be neglected or forgotten, yet they are not the ends for which science is taught.

Every progressive teacher is confronted with the problem of objectives. Unless the many objectives can be organized on a working basis they are more likely to be a hindrance than a help. Without working objectives a course of study becomes aimless. The discovery of working objectives demands a technique that can be applied and used in connection with various lists of objectives, various courses of study, and in various environments. The technique presented by the writers in this paper is one which any teacher can use in his own environment and adapt to his own educational needs, and the educational needs of his pupils.

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School Garden Activities Related to Elementary Science Instruction in the District of Columbia Public Schools*

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It shall be my endeavor to present for your consideration some of the aspects of, and relationships between, the activities in the school garden and the program in elementary science carried on in the public schools of the District of Columbia. I find that the president of this Society has struck the main theme for this paper. In her study of the Natural Science instruction in the German elementary schools, Lois Meier Shoemaker makes this statement:

> Experience-getting for the child is the keynote in American instruction in natural science today. As in German schools the classroom is considered a work room. American educators *stress* contact with things but German teachers actually *provide* more contacts with natural science material through instructional walks, long excursions, trips to the country school home and in the use of the school garden.

One of the ideas gathered from the work of Shoemaker is the vital integration between the garden program and the science program in the German schools. In the city of Washington, we, too, believe that the value of the garden work is in direct proportion to the extent to which it provides an opportunity for pupils to try out and live with things or ideas about which they have studied or to gain a background of actual experience that will lead to enriched understanding of ideas about which they will study.

We have found the fifth grade a satisfactory level for the actual garden work because the subject matter in science, taken up in connection with this unit, runs parallel with and supports the units in social science of this grade.

Before we discuss the garden unit, there is another point which needs explanation, that is, while the fifth grade devotes about half of its allotted time for science to the garden unit, the other grades participate to some extent, for the garden is used to make meaningful science instruction on any grade level.

In connection with this, I should like to cite as an illustration the use of the school garden in the fourth grade, where bees are studied. The

* Presented at the annual meeting of the National Council of Supervisors of Elementary Science at Minneapolis, Feb. 25, 1933.

observation hive is placed in a window of the classroom. The children are encouraged to ask questions and are referred to the hive and garden, as well as books, to find the answers to their questions. Last fall the Webb School, fourth grade, asked 143 questions about bees, 16 of which were answered by watching the bees in the garden.

During the winter, a background for the fifth-grade garden unit is given in geology. This is largely classroom work. It includes such subjects as rock formation, testing to find out several kinds of minerals, agents involved in weathering, types of soils produced, and the relative values of different soils.

This unit contributes to an understanding of several of the major objectives of science—the age of the earth, result of action of natural forces. It encourages an appreciation of such principles as: man's conception of truth changes, and there is a cause for every effect. In this way some basis is given for the understanding of soils.

In my own experience as a garden teacher, I remember the joy manifested by pupils as they recognized things which had been presented in the classroom. One boy, I recall, picked up a piece of rock which was about to crumble and crushed it in his hand, after first holding it up and getting his classmates to identify it as granite. Then he said, "This is weathered rock; it changes to soil in my hands. It is inorganic; it never lived." Then I can still think of the dead rabbit which almost caused a riot because it was considered so desirable as a source of organic soil. And the argument was only settled by allowing the disputants to divide the rabbit. All that one boy received was a piece of fur, but he carefully buried it under the spot where radishes were to be planted. He maintained that the fur was the cause of his having the largest radishes grown that season.

In connection with organic material the school-garden compost pile is the means by which gardens are enriched and an opportunity is given to the pupils to discover much about the rôle of bacteria in the drama of life, as well as to stimulate much interest in chemistry. These composts are huge affairs made in the fall from leaves hauled in from the public parks. These are mixed with soil, superphosphate, and ammonium sulphate. This work is quite heavy and the weather is rather treacherous for outdoor work with classes, so the composts are mixed by a young man employed to do such work on the gardens. The children watch at recess time and are allowed to get a bag full of each of the ingredients. They are permitted to dig in the compost to see what is happening. They are not forced to experiment but such is their interest in the garden that they are interested in all that happens to it. Soon bacteria begin to work

and the pile heats up a bit; the leaves rot far more rapidly than they do outside of the pile. The children then begin asking questions. Why are the leaves decaying so fast? What makes the compost warm even on a cold day? Why does the gardener turn it over every few weeks? What happens when the air strikes the under side? Why does he leave a hole in the top? In this work, as in other science units, the teachers are instructed not to answer children's questions but to help them answer their own. The children already have the ingredients used in making the compost, so they talk about how they can find out what it is that is making the compost of leaves change into rich black soil. Under the guidance of the teacher, they arrange their experiments in some such way as this:

There will be two jars of leaves and soil.
There will be two jars of leaves and soil and superphosphate.
There will be two jars of leaves and soil and superphosphate and ammonium sulphate.

The jars are made up in duplicate so there will be two complete sets. Then one whole set can be sterilized so as to kill all bacteria.

Through this work of mixing up materials and watching them, they are introduced to the action of bacteria of decay. This prepares the way for the understanding of life cycles, as well as some chemistry connected with basic and acid reactions and their effect upon plant growth. The children soon discover that leaves not mixed with soil and chemicals become sour, pickle, and do not soon decay; while on the other hand the leaves that are composted do not give an acid reaction when tested. Their attention is called to some differences in the flora of the woods the ordinary garden and the significance of the acid content of the soil in its determination. They give some consideration to the effect of different kinds of bacteria in causing common colds, which often keep them out of school. They find that information gained in successfully handling garden bacteria may be applied in preventing the entrance of bacteria into their own bodies.

When in the spring and summer these children dig about in the gardens, they are always interested in the evidences of bacteria in the soil. As the weeks go by and they live outdoors with the ideas gained in the classroom, these facts become a part of their thinking and, ever after, can form a basis for further work along these lines. To cite an incident in connection with the legumes raised in the garden, children often find the nodules on the roots and become quite interested about them.

Experiences of the garden are used to make meaningful teaching in the classroom. Later on in the junior high school, these same children may study a unit on bacteria in which they take up nitrogen fixing bac-

teria. Those children who have had an opportunity to look at the nodules and spade the bean plants under the soil when the harvest was over, have a background of experience that has significant bearing upon the course of study.

The balance in nature becomes a reality when they find a large army of aphids sucking on their carrots and the larva of the ladybird beetle making a feast of the aphids. Man's struggle to maintain the artificial balance set up by him is strongly emphasized as, throughout the summer garden classes battle with bean beetles and other destructive insects in the animal kingdom and weeds in the plant kingdom.

Hoeing is more interesting to them when they understand the reasons for doing it. After learning of the action of water on soil, they talk about watering a garden with a hoe. Earthworms become valuable adjuncts to a garden as well as to a fishing expedition.

One of the most interesting projects develops in the fall when the zinnias are all in full flower. Each grade selects a different color, if there are enough colors. They gather the seeds of their chosen color. In the spring, they plant the seeds and to their surprise they do not have exactly the same color that they planted. The study of heredity is a difficult subject for the elementary school, but the foundation for it can be laid there.

In the capital of our nation, more people live in homes with gardens, either front or back, than live in apartments. Gardening is an activity entered into with great enthusiasm both by adults and children. Home gardening is encouraged and the number of gardens which children make at home is approximately seven thousand for the approximately twenty thousand children in the fourth, fifth, and sixth grades of the elementary schools of the city. Neighborhoods coöperate with the school in promoting home gardens by means of contests and other forms of encouragement. The Georgetown Garden Club, inspired by a lady from Evanston, Illinois, has evolved the children's flower market, where plants are sold to children for a penny each.

There are significant differences in the value derived from home and school gardens. Home gardening among children is promoted by adult groups more from a civic standpoint. Young gardeners are less destructive of property than are children deprived of this type of self-expression. School gardens, on the other hand, are outdoor laboratories where the civic values are recognized, but in addition, science instruction is definitely planned and provision made for activities that will interpret the course of study in science.

In order to make the school garden afford as wide a range of expe-

rience as possible as well as having it beautiful, we encourage the planting of perennial shrubs and small trees, the making of pools, putting up bird houses, setting out cages in which to keep insects for study. Some gardens are surrounded by hedges, others by fences. In the case of the latter it is possible to keep such animals as toads and turtles. In one garden the turtle laid eggs, to the great delight of the children. Special plots of ground are set aside and designated as geography plots. In these are planted corn, wheat, rye, and cotton. These samples of cotton came from one of our gardens, the Brookland. It was in this garden last fall that one boy learned to appreciate the work entailed in gathering cotton. He said, "I have ginned cotton for a half-hour and I haven't enough to show on the scales!"

The following incidents will illustrate not only the integration of science and gardening, but the vital part that gardening plays in the lives of the school children of Washington, D.C.

Last spring someone visited the H. D. Cooke School garden. In the center of this garden there is a honey-locust tree and in its shade sat a class of kindergarten children in their little chairs. The teacher was reading about the mother house wren and, as she read, the children were watching a real mother house wren as she went flying about the garden and into the bird house to deliver food for hungry young ones.

On another occasion a second-grade group was seen watching the school turtle as he walked about the garden. The children were modeling specimens for their Robinson Crusoe table.

The slides which follow will feature the fifth grade at work on the garden unit. It is easier for the photographic plate to catch the physical activities of the garden than the more illusive activities that carry out on the garden the thoughts of the classroom. Nevertheless, I shall endeavor to point out the closeness of the integration as we proceed.

In closing, I will sum up by saying that in Washington we feel the garden affords an additional classroom located outdoors in which it is possible to study science under controlled situations.

It is in the sixth grade that the children who have had school-garden experience show an understanding of science which far exceeds that among the children who have been denied this experience.

As children literally reap what they sow, their respect is deepened for nature's invariable laws. As they wrestle with nature for her secrets they gain a facility in the use of scientific methods—yes, even the methods of the laboratory are delightful, since they are full of significance in solving interesting problems, and through attitudes, skills, and knowledge gained, they develop a clearer understanding of the principles that underlie the sciences.

A Critical Analysis of Pupil Responses to the Concepts of Mechanics in High School Physics*

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The Problem

The present investigation of high school physics has been conducted in order to measure, to a larger degree than has hitherto been done, first, the efficiency of learning as it is now being carried on, and, second, to locate the dominant errors made by pupils in exercises based upon the concepts of mechanics and, third, to analyze the processes by which pupils arrive at these dominant errors.

The isolation of the dominant errors and the analysis of the processes by which pupils arrive at these dominant errors should provide physics teachers with material which they may utilize in the revision of their procedures, and in the reorganization of the content, to the end that these dominant errors and the incorrect processes used by pupils may be eliminated.

The dominant errors made by pupils after they have studied mechanics provides information concerning the inherent difficulty of the concepts. There are many other factors which must be considered in determining the inherent difficulty of an item, one being that of the time devoted to teaching the concept. No attempt is made in this investigation to ascertain the amount of time used in teaching a concept or whether it was taught or not. Neither was a pre-test administered before any instruction was given in mechanics so that the gain could be measured. This investigation is concerned with the responses which pupils make to situations based on the concepts of mechanics in order that teachers may be provided with some factual information upon which they may base their reorganization of content or their revision of instructional procedures.

Construction and Administration of the Drills

Four textbooks, four courses of study, and four research studies were analyzed in the selection of the fundamental concepts to be used in the

* A summary of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, in the Department of Education, in the Graduate College of the State University of Iowa, 1931.

construction of the drills for this investigation.† A fundamental concept in this investigation is defined as a definition, principle, law, or fact which comprises a complete idea of some physical phenomenon. In addition to this analysis, the fundamental concepts were validated by the judgment of an expert in physics. A total of 152 concepts were selected as valid.

The mechanics drills were constructed according to a definite pattern in order that the various concepts might be presented to the pupils in different situations as well as at repeated intervals. This distribution gives a better measure of the efficiency of instruction and furnishes more evidence for the selection of dominant errors. When the drills are used in conjunction with instruction in mechanics, this repetition of concepts will provide for maintenance.

The formulas to be used in the drills were validated by means of textbook analysis. The technical vocabulary used in constructing the drills was selected from the *Technical Vocabulary of High School Physics*, by Pressey, and the *High School Science Terminology*, by Frank and White.

There were several different types of items used in the different drills, i.e., completion, matching, multiple choice, one-word, numerical problems, diagrams, and a modified true-false. The true-false exercises involved writing in the correct response provided the exercise was false. For all drills except those involving the true-false exercises, the total score was the sum of the correct responses, each part of an exercise being considered as a separate item. Scoring of the true-false exercises was based upon the correct responses which were written in for the false exercises.

Treatment of the Data

In this investigation 8,127 drills, 246,379 different exercises worked by approximately 2,100 pupils in forty-three different school systems of varying sizes located in fourteen states, were scored and analyzed. Every exercise in each drill was marked R, W, or O according to whether it was right, wrong, or omitted. These data were then punched on Hollorith cards so that an item analysis could be made, using the Hollorith tabulating machines. The data on the item analysis were secured from the cards for every exercise of each of the twenty-five drills. From the individual analysis of every exercise the number of different wrong responses as well as the actual wrong responses was obtained.

† A complete treatment of the experiment is included in the data which are on file in the College of Education Library at the State University of Iowa. Only a brief treatment is included in this abstract.

The reliability of each drill was computed. The "index of goodness" for each exercise was determined in an attempt to validate the exercises. A comparison was made of the scores made by pupils using each of four different textbooks in order to measure the difference in achievement shown by pupils using each textbook. A ranking was made, by using the T score technique, of the variability of achievement on the drills by the pupils of the different schools.

Every exercise in each of the 8,127 drills was analyzed by tabulating every wrong response in order to locate the dominant errors and the processes used by the pupils in arriving at each wrong response.

The 100 most difficult exercises were determined by two different methods, one in which the per cent of error was based upon the attempts and the other in which the per cent of error was based upon the total error (wrong responses plus omissions). The 152 concepts were ranked according to difficulty on the basis of per cent of total error (wrong responses plus omissions) in terms of pupils' opportunity for making an error. Another study would very likely show a somewhat different ranking of these 152 concepts.

A selection of the exercises with their dominant errors was made using the following criteria. First, the exercise must have been attempted by at least 200 pupils (all drills were administered to over 300 pupils); second, the exercise must have been missed by fifty per cent of those pupils attempting it. To justify these criteria it may be said that an omission was considered an error in this investigation. The exercise might have been omitted because the pupil did not know the correct response, had not studied the concept involved, did not have sufficient time, or for one of many other causes. Since practically all of the co-operating teachers felt that twenty minutes was sufficient time, and since exercises which had a high frequency of wrong responses, and since an omission does involve some type of inability of the part of the pupil, omissions are considered as errors. However, in analyzing the wrong responses, omissions, even though they are errors, do not aid in selecting the dominant errors made by the pupils.

Thus it may be that difficult concepts determined on the basis of total error (wrong responses plus omission) in terms of pupil opportunity may not be represented in the analysis by all, or any of the exercises in which it occurs, likely because the exercise was not attempted by 200 pupils or possibly because it was not missed by fifty per cent of those attempting it. Even so, it is reasonable to assume that the concept has some inherent difficulty, or the exercises based upon the concept are difficult or faulty. This does not affect the analysis of the wrong responses to the items attempted.

The Data

The reliability coefficient odds versus evens, for each drill was computed. The total number of drills administered (range 308–335) was used in computing the reliability coefficients of each drill. By the use of Brown's formula,

$$R_x = \frac{N_r}{1+(n-1)r}$$

the reliabilities for the whole drills were computed. The reliabilities are here shown:

Drill	R_x	*Drill*	R_x
1	.85±.01	14	.79±.01
2	.66±.02	15	.74±.02
3	.69±.02	16	.79±.01
4	.76±.02	17	.81±.01
5	.79±.02	18	.80±.01
6	.82±.02	19	.82±.01
7	.78±.01	20	.90±.00
8	.75±.02	21	.76±.01
9	.70±.02	22	.78±.01
10	.78±.01	23	.74±.02
11	.80±.01	24	.85±.01
12	.80±.01	25	.85±.01
13	.80±.01		

The experimental method for validating individual test items suggested by Ruch,[1] and Lindquist and Anderson,[2] was used in determining the degree to which each exercise discriminated between pupils of superior ability (upper quartile) and those of inferior ability (lower quartile), although an item which does not discriminate between these two groups of pupils may not be of value in an achievement test, it may be of value in a drill, especially if the drill is to include only minimum essentials. Items which do discriminate between these two groups of pupils are of value in drills as well as in achievement tests, if the drills are constructed so that superior pupils are to be challenged by the problem situations presented in the drills. The ratio between the error made by the superior group (upper quartile) and the errors made by the inferior group (lower quartile) is called the "index of goodness." An exercise having an index of 1.00 was answered correctly by the same per cent of superior as of inferior pupils; therefore it is of no value in discriminating between these groups. An index of 3.00 means that the exercise was answered correctly three times as frequently by superior pupils as by inferior pupils. The "index of goodness" obtained for the exercise of the twenty-five mechanics drills are relatively high although much variation is shown.

Of the total number of exercises, 895, only one exercise had an index of less than 1.00, 210 exercises (23 per cent) have an index between 1.00 and 2.00; 143 exercises (16 per cent) have an index between 2.00 and 3.00; 541 exercises (51 per cent) have an index greater than 3.00, while many items have an index higher than 10.00; and 91 exercises (10 per cent) have an index of ∞ which shows perfect discrimination between these two groups. There is a high correlation between the "index of goodness" of an exercise and its difficulty based on per cent of error, although this correlation was not computed for this study.

The inherent difficulty of an exercise or concept cannot be determined by a count of the errors made by pupils on that exercise according to Hurd.[3] There are many other factors to be considered in determining the inherent difficulty. The concept may not have been taught, it may have been poorly taught, or the pupil may not have studied the concept a sufficient length of time to master the concept. These factors do influence the errors made by pupils, but until a workable technique has been developed and until the actual time required for learning the various concepts has been determined by scientific investigation, inherent difficulty can only be based upon the number of errors made by pupils. It may be that fourteen weeks is not sufficient time in which to teach the 152 concepts of mechanics, but such studies, and others which have been carried on, may cause physics teachers to devise means for reorganizing either the learning materials now included in the present curriculum, or to devise teacher procedures which will reduce the errors made by pupils to various concepts by teaching their pupils in such a manner that the pupils will at least not make the dominant errors which this analysis shows they do make at the present time.

The contribution which this investigation makes lies in the determination of the dominant errors which pupils make on the various exercises. In order to show what is meant by a dominant error, the following explanation is given:

Concept 82. "The method of finding the resultant of two or more forces is called the composition of forces." The following exercise is based upon this concept: Drill 13, Exercise 16, "Two forces, 30 lbs. and 40 lbs., act at an angle of 90° with each other. (a) What single force could produce the same effect? (b) What name is given this third force?" Part (a) was attempted by 262 pupils and omitted by 67. Of the 262 attempts, 106 or 40 per cent were correct, and 156 (59.5 per cent) were incorrect. This is 67.8 per cent error if based on total errors (wrong responses plus omissions). There were 35 different wrong responses in addition to the omission error, and of these 35 different wrong responses, the error of

first dominance constitutes 34.6 per cent, while the error of second dominance constitutes 17.28 per cent, and the error of third dominance constitutes 10.24 per cent. These three most frequent dominant errors constitute 62.12 per cent of the total number of errors made. The other 32 wrong responses constitute the remaining 38 per cent of the errors.

An examination of these three dominant errors and the processes used by the pupils in obtaining them shows that the error of first dominance is 70 lbs., obtained by adding 30 lbs. and 40 lbs. The error of second dominance is 35 lbs., obtained by averaging 30 lbs. and 40 lbs. The error of third dominance is 10 lbs., obtained by subtracting 30 lbs. from 40 lbs. Pupils, in attempting to find the value of the resultant of two angular forces in this case, added, averaged, or subtracted the given forces. These particular dominant errors would not be so significant if they only occurred as responses to this one exercise, but in solving every similar exercise, the pupils made these same three dominant errors.

If the physics teacher is made aware of these three dominant errors which pupils do make consistently in working problems which involve this concept, teacher procedures may be devised to eliminate these three dominant errors and of all the possible wrong responses. If only these three are eliminated the per cent of errors made will be significantly reduced and hence the efficiency of learning will be materially increased. This investigation does not propose to devise teacher procedures for the elimination of these dominant errors, but proposes only to determine these dominant errors so that teachers may be made aware of the specific difficulties which pupils have in learning the concepts of mechanics.

Many errors are revealed which involve vocabulary difficulty or definition of terms. To illustrate, pupils either have not been taught, or have not learned the difference between the resultant of forces, the equilibrant of forces, and the component of a force. Knowing that this particular difficulty exists and that pupils have a confused or hazy conception of these terms and that they are unable to differentiate between them, the teacher should be certain that at least these terms will be learned correctly by the pupils in his classes, granting that these definitions are significant and important enough for inclusion in the mechanics materials of learning.

There were six different textbooks used in the forty-three different schools included in this study. Two textbooks were used by so few pupils, and as additional rather than sole adoptions, that only four were considered in the comparison which was made of the achievement of the pupils using the various textbooks. This particular section of this investigation was performed in order that evidence could be presented to

show that the drills were not based upon any one drill rather than to exhibit the merits of any one textbook. The findings are interesting in view of the fact that the same order is not followed in teaching the various topics.

The average score earned on each drill by the pupils using each of the four different textbooks was computed. The mean and standard deviation for the distribution of averages earned on the twenty-five drills for each textbook was computed.

In order to show whether the difference in averages is reliable, the reliability of the averages, the reliability of the difference between the averages, and the ratio $\frac{D}{\sigma \text{ diff}}$ was computed. A value of $\frac{D}{\sigma \text{ diff}}$ of 3 is indicative of complete reliability. In none of the six comparisons was there complete reliability (range .32–1.83). From this data it seems evident that pupils using one textbook show approximately the same ability as the pupils using any of the other three textbooks. The differences which the textbook might have caused are not significant.

The averages made on each drill by the pupils in each of the forty-three experimental schools were computed. By means of the T score technique, these averages and a composite T score, based upon the number of pupils taking each drill in each school, were computed. By means of these composite T scores the variability of the schools on each drill was ascertained. There is considerable variation (range, composite T scores 24.52–62.08) shown but, in general, one can say that the achievement in one state compares favorably with that in another.

(*To be concluded in the December issue*)

The Nomenclature of Biology Courses in Teachers Colleges

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These are days when students of education are endeavoring to ascertain the best curricular offerings for each of the special purposes for which colleges are organized. The field of the biological sciences has grown apace with almost no effort on the part of any one to standardize nomenclature. Courses in various colleges are often called by different names regardless of the fact that they are practically identical. It seems that little effort has been made to solve this problem.

The purpose of this study is to investigate the offerings of a representative group of teachers' colleges having Class "A" rank with the American Association of Teachers Colleges, to discover the nomenclature used for these courses, and to discover trends, if any, toward uniformity. The data for this study were collected by Professors W. J. Knobbs and Lewis Clevenger of the Northeast Missouri State Teachers College, by an analysis of the catalog bulletins of sixty-five teachers colleges having Class A rating.

Table I shows the courses offered, the frequencies of occurrence of each subject, and the per cent of colleges offering each course.

TABLE I

TITLES OF BIOLOGY COURSES WITH FREQUENCIES OF OCCURRENCE AND PER CENTS OF TOTAL NUMBER OF COLLEGES OFFERING EACH COURSE

Subject	*Frequency*	*Per cent of total*
General Zoölogy	52	80.0
General Botany	65	100.0
Heredity and Genetics	57	88.8
General Ecology	16	24.6
Plant Physiology	31	47.7
Plant Taxonomy	15	23.1
Economic Entomology	43	66.4
General Bacteriology	48	73.9
Invertebrate Zoölogy	31	47.8
Vertebrate Zoölogy	31	50.8
General Physiology	47	72.4
General Biology	45	69.4
Comparative Anatomy of Vertebrates	21	32.3
Vertebrate Entomology	30	46.2
Methods of Teaching Biology	36	55.5
Physiology of Maintenance	1	1.5
Cryptogamic Botany	5	7.7

Subject	*Frequency*	*Per cent of total*
Spring Flora	10	15.4
Bird Study	8	12.3
Eugenics	10	15.4
Principles of Animal Biology	3	4.6
Advanced Physiology	2	3.1
Plant Ecology	5	7.7
History of Biology	10	15.4
Physiology of Adjustment	1	1.5
Problems in Biological Science	6	9.2
Advanced Zoölogy	4	6.2
Advanced Bacteriology	7	10.8
General Histological Technique	8	12.3
Field Zoölogy and Taxonomy	10	15.4
Field Zoölogy	8	12.3
Animal Ecology	19	29.2
Structure, Development and Relationship of Chordate Animals	7	10.8
Special Zoölogy	7	10.8
Systematic Botany	19	29.2
Botanical Technique	12	18.5
Zoölogical Technique	8	12.3
Economic Biology	5	7.7
Advanced Biology	7	10.8
Sex Determination	1	1.5
Endocrinology	1	1.5
Economic Zoölogy	7	10.8
Economic Botany	4	6.2
Nature Study	14	21.6
Animal Biology	7	10.8
Morphology of Plants	14	21.6
Biological Techniques	1	1.5
Plant Histology	1	1.5
Morphology of Higher Plants	3	4.6
Principles of Biology	4	6.2
Plant Pathology	6	9.2
Mammalian Anatomy	1	1.5
California Plants	1	1.5
Special Problems	2	3.1
Forestry	4	6.2
Evolution	9	13.8
Protozoölogy	1	1.5
Special Mountain Botany	1	1.5
Introduction to Fungi and Plant Diseases	4	6.2
Morphology of Thallophytes	3	4.6
Morphology of Spermatophytes	4	6.2
Plant Geography	2	3.1
Advanced Animal Ecology	1	1.5
Animal Behavior	2	3.1
Educational Zoölogy	1	1.5
Current Biological Literature	1	1.5
Human Biology	3	4.6
Physiology and Morphological and Evolution of Vertebrate Zoölogy	1	1.5
Systematic Zoölogy	1	1.5

Subject	*Frequency*	*Per cent of total*
Mycology and Plant Pathology	3	4.6
Ornithology	12	18.5
Histology	11	17.0
Human Anatomy	4	6.2
Spring Botany	1	1.5
Field Botany	8	12.3
Biological Materials	1	1.5
Trees	8	12.3
Plant Biology	2	3.1
Organic Evolution	5	7.7
Introduction to Biological Science	2	3.1
Cytology	4	6.2
Fundamentals of Biology	1	1.5
Physiology of Digestion	1	1.5
Health	1	1.5

From the table it is seen that there is a somewhat chaotic state of affairs as regards the title of courses in the various biological sciences. It would seem that the first course in zoölogy, for example, might be uniformly called general zoölogy, and the first course in botany might be similarly called general botany. Special courses in zoölogy might well be called vertebrate zoölogy, and invertebrate zoölogy. Bird study might be uniformly called either ornithology or bird study, but it should be agreed upon to use one or the other title. It is a matter of doubt whether the large number of specialized courses found in this list could be justified in a teachers college. It seems certain that there should be a determined effort to systematize nomenclature so that there would not be such a chaotic state of affairs as is indicated by Table I. There is much lack of uniformity in naming of courses in other sciences, but it is doubtful if so chaotic a state of affairs could be found in any other field.

It should be pretty generally agreed that there are certain fundamental fields with which the prospective teacher of the biological sciences should be familiar. Certainly general botany, general zoölogy, general bacteriology, ecology, taxonomy, eugenics, entomology and probably plant physiology should be a part of a major in biology. It seems equally certain that teachers colleges could hardly justify graduating a student with a major in one of the special fields of the biological sciences, except in the case of the few teachers colleges that offer graduate degrees. The demand is, largely, for teachers who are prepared to teach biology, botany or zoölogy in high school. Should there not be an effort, particularly in teacher-training institutions, to meet this problem, systematize nomenclature, and reach closer approximation to agreement as to what constitutes adequate preparation for the teacher of biology courses in high school?

Are We Wasting our Chemistry Students' Time?

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This article is the result of a study completed recently, by the author,[1] to determine the present practice in high school and college chemistry teaching. The study came as a result of a growing conviction that elementary chemistry should give the students a mastery of the principles of chemistry rather than a mass of facts to remember and that our present chemistry courses are not accomplishing that purpose. McPherson says,

> And some seem to forget that all so-called practical chemistry to be of any value must be based upon fundamental theoretical principles. We must remember that the mere storing of one's mind with facts, however interesting they may be, is not education, neither is it science.[2]

The scores of most standardized chemistry tests, as well as of most other tests, give dishearteningly low results for the efforts of the chemistry teacher. One needs only to compare the median score with the maximum possible score, of any good chemistry test, to get the full significance of the wasted efforts in the chemistry classroom. To many chemistry teachers, who have given any thought to the subject, there seems to be, in most modern chemistry texts, too great an amount of purely factual material which is unrelated to the principles being stressed. Also, there has been a growing conviction that the high school and the college are trying to do the same thing, not only at an enormous waste of time and money, but also to the detriment of the subject of chemistry. As far as could be determined, no study to determine the relative amounts of textbook space devoted to facts and to principles has been made and only a few studies have been made of the overlap of high-school and college chemistry. None of the latter were made primarily to determine the extent to which the principles of chemistry overlap in high school and college.

The results and the conclusions of the study, summarized herein, may be severely criticised by many chemistry teachers and especially by those primarily interested in college chemistry. Those chemistry teachers, who think that a large mass of facts, comprising over one-half of the course, are necessary for teaching chemistry, might do well to examine a mathematics or physics course. Are many obscure or unrelated

facts necessary to teach a student the principles of algebra or physics or do we have to include a history of the important theorems to teach the principles of geometry? Again, for those teachers who are skeptical of the advisability or possibility of segregating high-school from college chemistry and reducing the overlapping, one might ask them to examine the high-school and college mathematics curricula which are prevalent throughout the United States. Few educators would advocate repeating high-school algebra and geometry in college for those who have mastered those subjects in high school.

The purpose of the study, now reported, was twofold. First, it was proposed to find the present tendency in chemistry teaching in both high school and college, as revealed by the contents of the most generally used textbooks. Are beginning chemistry students being taught the principles of chemistry or are they expected to memorize a mass of factual material which can easily be found in any good treatise on general chemistry? Second, it was sought to determine the extent of articulation or the extent of overlapping between high-school and college chemistry courses as presented to the same students. When a student, who has studied chemistry in high school, enrolls, in an inorganic chemistry course in college, is he allowed to continue with the subject from the point at which he left off in high school or is it assumed that he acquired no knowledge of the principles of chemistry in his high-school course? Koos has the following to say about the overlapping of chemistry in high schools and colleges.

> It is clear from the comparisons made that although there are some differences between high-school and first college courses in chemistry, they are much alike, consequently, if the materials presented in high-school courses may be presumed to be secondary in character, there is relatively little in these first college courses which is not purely secondary. Moreover, if a student takes the course in general inorganic chemistry in college after having had the high-school course (which is often done), he is repeating almost all of it, even in that relatively small proportion of higher institutions where such a student enters upon a course in general inorganic chemistry presumed to be administered for those who offered the high-school unit for admission, there must be a large amount of repetition.[3]

The six most commonly used high-school textbooks and the six most commonly used college textbooks of chemistry in the United States served as the basis for the study. Those textbooks were determined from questionnaires answered by thirty-two state departments of education and by the chemistry departments of fifty-one of the leading universities and colleges in the United States. Questionnaires were sent to all state departments of education and to all institutions of higher learning with an enrollment of 5,000 or more and to some of the better known smaller institutions, seventy-six in all. The results of the answers to the

questionnaires indicate that the twelve textbooks, used in this study, are used by a large majority of all chemistry students in the United States and that the remaining minority of chemistry students use a large variety of textbooks, probably none of which are used very extensively. Therefore, since Koos[4] has determined that the textbook represents the classroom content of chemistry courses, those textbooks used for this study probably fairly accurately represents the chemistry taught throughout this country.

The textbooks were analyzed to determine the word space devoted to each principle, each type of factual material and to each type of mathematics by each textbook. That material was then totaled for the high-school textbooks and for the college textbooks and summarized according to the percentage of word space devoted to each type of material. For the analysis sixty-two principles, thirteen groups of factual material, each subdivided into six subgroups, and five types of mathematical problems were used. Space does not permit the listing of these principles, types of factual, material and problems. All factual material used as a basis of understanding of a principle was considered as part of the discussion of the principle.

The following tables present a summary of the findings from the study of the textbooks.

TABLE I

THE PER CENT OF THE TOTAL WORD SPACE DEVOTED BY THE HIGH-SCHOOL AND COLLEGE TEXTBOOKS TO PRINCIPLES, FACTS, AND MATHEMATICS

Division	*High School Texts*	*College Texts*
1. Principles..............	37.21	39.00
2. Facts..................	59.54	59.55
3. Mathematics............	3.22	1.45

It will be noted from the foregoing table that more than 59 per cent of the total word space, in the high-school textbooks studied, is devoted to factual material and that the same is true of the college texts studied. It will also be noted that less than 38 per cent of the word space of the high-school texts and only 39 per cent of the total word space of the college texts is devoted to the principles of chemistry. It should also be pointed out that none of the six high-school texts devotes more than 42 per cent and none of the college texts devotes more than 50 per cent of their total word space to the principles of chemistry. Only two of the college texts devote more than 44 per cent of their total word space to the principles of chemistry. One other striking fact is the low percentage of the total word space of all texts devoted to mathematics; the high-school texts devote more than twice the per cent of their total word space to mathematics as do the college texts.

The college textbooks from which data were taken are the ones which are most generally used in classes intended for those students who have studied high-school chemistry. Keeping that fact in mind, while examining Table I, one might assume that there is considerable overlapping between the high-school and college courses that are given to the same students. However, the following data should leave little doubt in one's mind as to the extent of the overlapping. The sixty-two principles of chemistry, found in the high-school and college texts, were ranked according to the total word space devoted to each by the high-school and by the college texts. Those two ranks of principles were then correlated by Spearman's rank difference formula. The coefficient of correlation was found to be $.82 \pm .03$. This is interpreted as meaning that there is a great deal of similarity in the per cent of the total word space devoted to each principle of chemistry by the high school texts and by the college texts.

The overlapping of the factual material was examined by regrouping it into eight main groups and ranking those groups according to the word space devoted to each group by the high school and by the college texts. Table II represents the results of those rankings.

TABLE II

COMPARISON OF THE RANK OF DIFFERENT DIVISIONS OF FACTUAL MATERIAL ACCORDING TO WORD SPACE IN HIGH-SCHOOL TEXTS WITH THE RANK IN COLLEGE TEXTS

Division	*Rank in High-School Texts*	*Rank in College Texts*
1. Properties	1	2
2. Compounds	2	1
3. Preparation	3	3
4. Organic chemistry	4	5
5. History	5	4
6. Uses	6	7
7. Other facts	7	6
8. Occurrence	8	8

The names of the divisions above are shortened and stand for the properties of elements and the most important compounds, the less important compounds, preparation of the elements and the most important compounds, organic chemistry, history and general discussion which is not included in any of the other divisions, uses of the elements and the most important compounds, other facts not included in any of the other groups, and occurrence of the elements and the most important compounds.

From the above table it may be seen that there is a rather close comparison of the per cent of the total word space devoted to the different types of factual material by the high-school and by the college texts.

The following conclusions have been drawn from the foregoing data:

1. In high-school chemistry over one-half of the student's time is wasted in the memorization of factual material, or at least the time is wasted in the study of facts that do not directly contribute to the mastery of the principles of chemistry. In other words less than half of the time alloted, supposedly for the mastery of the principles of chemistry, is used for that purpose.

2. The same fault is found with the college courses with a very slightly greater amount of space devoted to principles in the college course.

3. Very little mathematics is required of either college or high-school chemistry students. Less mathematics is included in these courses than is sometimes suspected.

4. In college chemistry the tendency seems to be toward the segregation of those students who have had high-school chemistry from those who have not had high-school chemistry. However, there seems to be very little difference in the content of the courses offered to the two groups of students, excepting in intensity.

5. There is a very high correlation between the high-school chemistry course and the college course which is offered to those students presenting high-school chemistry for entrance credit to college. This means that there is a large degree of overlapping in the two chemistry courses.

6. Considering the first, second and fifth conclusions together it appears that there is a great deal more loss of time in chemistry than is at first suspected. The student who is taking chemistry in college after having had it in high school is almost completely wasting his time while he is studying the elementary college course, or the time spent on high-school chemistry was a total loss. The results of investigations by Cornog and Stoddard[5] indicate that the latter is not likely true in many cases.

References Cited

[1] Lucas, Loren T., "An Analysis of Chemistry Texts in Terms of Principles." Unpublished Master's thesis, Department of Education, University of Chicago, 1933. 65 p.

[2] McPherson, William, "Chemistry and Education," *Science* 72:485–493; November, 1930.

[3] Koos, Leonard V., *The Junior College Movement*. Boston: Ginn and Company, 1925. p. 276.

[4] *Ibid.*, p. 276–277.

[5] Cornog, J. and Stoddard, G. D., "The Chemistry Training of High School and College Students," *Journal of Chemical Education* 6: 85–92; January, 1929.

Abstracts 

General Education

ANDREWS, ROY CHAPMAN. "Explorations in the Gobi Desert." *National Geographic Magazine* 63:653–716; June, 1933.

This is a description of one of the most important scientific investigations that has ever been made. Many important "finds" were made, among the more notable being the dinosaur eggs and several remains of one of the very earliest mammals. It was a dangerous journey beset with many obstacles and much routine work, but it had its moments of excitement and fun, too! There are seventy-one illustrations, including twenty illustrations in color. —C.M.P.

ANONYMOUS. "The Results of Our First Test of Telepathy." *Scientific American* 149:10–11; July 1933.

In the March, 1933, number the *Scientific American* published a proposed test of telepathy asking readers to coöperate. The test consisted of having two persons act as an agent and a percipient in a series of tests involving 500 throws of a die. The agent was instructed to shake the die and to concentrate on the number uppermost. The percipient was then to "guess" the number aloud and the agent was to record the fact of "right" or "wrong" on a prepared chart. This issue of the *Scientific American* presents the results obtained in 120 cases. The results appear to point to the operation of something other than chance. Further data are needed before the question can be answered, either negatively or positively, as to whether telepathy has been proved.

—C.M.P.

ELIASSEN, R. H. and ANDERSON, EARL W. "Investigation of Teacher Supply and Demand Reported, since November, 1931" *Educational Research Bulletin* (Ohio State) 12:66–72; March 8, 1933.

The authors summarize the numerous factors mentioned in forty-nine articles on teacher supply and demand published during the last two months of 1931 and the year 1932 as influencing supply and demand in teaching. These articles are listed in the bibliography. —C.M.P.

DERRING, CLARA ESTHER. "Lists and Abstracts of Masters' Theses and Doctors' Disserations in Education." *Teachers College Record* 34: 490–502; March, 1933.

This is an annotated bibliography of the known available lists of theses and dissertations in the field of education. —C.M.P.

Science Education in General

POWERS, S. RALPH. "Science in Education." *New York State Education* 20: 520–523; 573–579; April, 1933.

Any real understanding of modern life and thought is impossible without some understanding of those comprehensive concepts which have been developed, for the most part, through study in the field of natural science. The author maintains this thesis with illustrations of attainment in the field of health, of progress in attaining leisure, and in the development of man's desire for mental adjustment.

A pattern for a program of science in education involving the major generalizations of science and the associated scientific attitudes is presented and discussed. Illustrations of a few of these generalizations and principles are included.

—C.M.P.

KNOX, W. W. "The Training of Science Teachers." *New York State Education* 20: 542–543; 587–589; April, 1933.

The author has made an investigation of the science training of 185 secondary science teachers in New York State. On the basis of this study the following interpretations were made: (1) A large percentage of science teachers are teaching science courses in which they have neither majored nor minored in college; (2) Prospective teachers in science have not been guided properly in the selection of courses which will be of the most benefit to them in their work; (3) The majority of teachers of science in large and small high schools have not generally received a well-rounded training in the science fields; (4) Teacher training institutions apparently do not take into consideration the fact that inexperienced teachers must secure their early experiences in small schools, that these teachers should be prepared for teaching such combinations; (5) School administrators often fail to select properly trained teachers.

The author presents the following as desirable minimum requirements for the training of science teachers:

High School Science:	
Science Major	18 hours
Science Minor	12 hours
Science Minor	12 hours
Science Elective	6 hours
Elementary Science:	
Science Orientation	6 hours
Advanced Physical Science	4 hours
Advanced Biological Science	4 hours
Science Education	4 hours

—C.M.P.

CARPENTER, HARRY A. "State Science Teachers' Association." *New York State Education* 20: 544; 583; April, 1933.

The article presents something of the history of the New York State Science Teachers' Association, its present status, and the values to be attained by membership. —C.M.P.

SEGERBLOM, WILHELM; HOPKINS, B. S.; BAKER, ROSS A.; and ROSE, R. E. "Symposium on Laboratory Notebooks, Records and Reports." *Journal of Chemical Education* 10: 403–414; July, 1933.

This is a résumé of the reports presented before the Division of Chemical Education at Washington, D.C. on March 29, 1933. Each of the above listed authors discussed, respectively, the following phases of laboratory notebooks, records and reports: (1) In the Secondary School; (2) In College; (3) In the Research Laboratory; (4) In Industry. Notes on the discussion of these reports are included. —C.M.P.

TIMM, JOHN A. "The Cultural or Pandemic Chemistry Course after Six Years of Trial." *Journal of Chemical Education* 10: 428–429; July, 1933.

This paper contains a review of the author's six years of experience in teaching a course in pandemic chemistry—a course designed for those students who do not intend to take advanced courses in chemistry. The course has been found most gratifying, both from the student's point of view and that of the author. —C.M.P.

BURTON, WALTER E. "Plant Growth Speeded in Midget Gardens." *Popular Science Monthly* 123: 4–35; 96; July, 1933.

The illustrated article describes methods now being used by experimental plant growers to reduce the size of gardens to a point where products formerly requiring a relatively large space can be grown in the backyard or even indoors. A combined watering and fertilizing device, especially adaptable to this trough method of growing plants, is explained. The use of a new type of fertilizer, as well as ethylene gas to hasten the process of maturing, are cited as advantages of this method. —C.M.P.

TAYLOR, WM. A. "Research in the Bureau of Plant Industry." *The Scientific Monthly* 37: 5–19; July, 1933.

This is a description of what one branch of the government is doing in applied biology. There are fourteen illustrations.

—C.M.P.

Science in Elementary Schools

CRAIG, GERALD S. "The Program of Elementary Science." *New York State Education* 20:524–526; 579–581; April, 1933.

A study of recent trends shows that elementary science is assuming a place of ever-increasing importance in the elementary school program. This is true despite the fact that the economic depression has caused the curtailment or even elimination of those subjects not rated as "fundamentals." The author presents the following as characteristics of elementary science: (1) The science of the elementary school must be liberal and cultural rather than vocational in character to be in keeping with the purpose of the school; (2) Instruction in elementary science must be balanced as to the major fields represented (Content must be selected with the entire environment of the child in mind.); (3) The learning elements and content should be challenging and intrinsically worth while (Science is the interpretation of the universe about us.); (4) It is quite important that there be a continuous program of science through the public school, beginning with the kindergarten and extending through our elementary and secondary schools. —C.M.P.

CURTIS, FRANCIS D. "The Emergence of Elementary Science." *School of Education Bulletin* (University of Michigan) 4: 86–88; March, 1933.

The following are listed as reasons to account for the dubious position and protean nature of the science work below the junior high-school level: (1) First and probably most important, is that because of the nebulousness and inadequacy of most of the nature study courses, administrators, supervisors and teachers have had an imperfect understanding and appreciation of the potential contributions which the study of elementary science might make, both to the grade children themselves and to society; (2) Elementary teachers as a group have not been trained to teach science; they have lacked an adequate grounding in its subject matter and principles; (3) The earlier widespread belief that children are unable to interpret and generalize upon the phenomena which they observe; (4) The traditional conservatism and inertia, which have so frequently blocked educational progress, have retarded all efforts to improve the nature and content of science in the grades.

Several influences have been together effecting a marked improvement in science at the elementary level: (1) A change in the major objectives of science teaching; (2) Recent progress in various centers toward the formulation of an articulated and integrated program of science teaching which shall begin with the first grade, or even earlier, and shall extend through the high-school years; (3) A growing demand for better trained teachers of science at all levels of work; (4) An authoritative and active leadership centralized in the National Association for Research in Science Teaching. —C.M.P.

PALMER, E. LAURENCE. "The Training of Elementary School Teachers in Science." *New York State Education* 20:541; 586–587; April, 1933.

One of the first criteria for the selection of content to be presented to elementary-school children or to their science teachers is based on accuracy. With it is closely associated experiences in testing truthfulness through the evidences of the senses and of logic.

Another criterion for the selection of offerings to science teachers in training pertains to the local significance of those offerings. It must be recognized that no teacher can be a master of all information which children may gain. There should be a correlation between science and local civic problems. —C.M.P.

BRUCE, G. V. "Some Essentials of an Elementary Science Unit." *Journal of Chemical Education* 10:484–486; August, 1933.

The only successful units are those built by the teacher who enriches his units with content, devices, technics, and spirit to fit the specific needs of the teaching situation. Some essentials of a unit are listed: (1) The unit shall present to the student a "total situation"; (2) The teacher shall present the unit in such a way that the student from the beginning of the study will see it in its totality, and will anticipate adventure in

the promise it holds for new experience, and with such challenge that he will claim ownership of the situation; (3) The activities of the unit should be of a nature to offer appeal in themselves; (4) The unit should make wide use of the reading activity. —C.M.P.

Bowers, R. E. "The Elementary School Science Room." *New York State Education* 20:537; April, 1933.

Brief mention is made of the desirable features of an elementary-school-science room. Progressive school leaders now recognize a science room as an essential unit of a modern school building. —C.M.P.

Jones, Arthur L. "Home-Made Lantern Slides." *New York State Education* 20: 551–552; 572; April, 1933.

The author describes the methods used by a sixth-grade geography class in making home-made lantern slides. Mention is made that a fourth-grade class also made a series of lantern slides. Illustrated. —C.M.P.

Science in Grades Seven, Eight and Nine

Shelton, H. S. "General Science." *The School Science Review* (England) 14: 458–467; June, 1933.

This is a discussion of a General Science Outline prepared by a Committee of the Science Masters' Association in 1932. In the opinion of the author it is not general science but a series of assembled units from each of the special sciences. There is also objection to it on the basis that it is too difficult for the pupils for whom it is intended and that it attempts to cover too much ground. Seemingly, each part of the course is to be taught by a specialist in that respective field of science rather than by a single teacher (as is the American scheme). The course covers three years and is to begin about the age of twelve years. —C.M.P.

Moose, Carleton A. "Science in Junior High School Grades." *New York State Education* 20:527; 581–582; April, 1933.

The author presents as the two major aims of science instruction in grades seven, eight and nine: first, to give to the pupils a thorough appreciation of his environment, and, second, a beginning should be made in the development of proper mental habits and attitudes towards the happenings in the pupil's environment. Science courses should not be centered around segregated objectives as "health" in one year, "physical sciences" in another year, and so on. —C.M.P.

Simpich, Frederick. "Men and Gold." *The National Geographic Magazine* 63: 481–518; April, 1933.

This article describes the modern quest for gold and the goldsmith's art. There are forty-four illustrations, eleven of which are in duotone. —C.M.P.

Pearson, T. Gilbert and Brooks, Allan. "Woodpeckers, Friends of Our Forests." *The National Geographic Magazine* 63: 453–479; April, 1933.

This is the fourth of a series of descriptive articles and paintings of all of the important families of birds of North America. The twenty-five portraits are by Brooks. Each portrait is accompanied by a descriptive sketch. —C.M.P.

Science in Senior High School

Oakes, Mervin E. "General Biology." *New York State Education* 20:528–529; April, 1933.

Functional values in the lives of the pupils will ultimately determine the place of biology in the curriculum. The author defines functional values as those which provide the basis of understanding for the needs of everyday life. "The study of biology will have functional values to the extent that it affects the lives of pupils by increasing physical well-being, by correcting erroneous ways of thinking, by removing unfounded fears, and by answering their questions in problematic life situations both as adolescents and as adults."

The author presents a list of eighteen questions as indicative of some of the possibilities of biology. —C.M.P.

FITZPATRICK, FREDERICK L. "A Method of Field Study in Biology." *Teachers College Record* 34:481–489; March, 1933.

A field course in biology, says the author, may be conducted in one of two general ways. The first method is to visit a number of localities, studying whatever features may be of interest in each place. The second general method is used in making some ecological surveys, and carrying on an intensive study of the interrelationship of species within a certain limited area, as well as the relationships of these species to their physical environment.

The author describes in some detail how he carried out the second method in a remote portion of a city park. The area selected covered about two acres and presented quite a diversity of fauna and flora. The students were divided into five groups, each studying a particular phase of the environment. One group paid especial attention to the trees of the area. A second group studied the birds; a third group, the insects and higher invertebrates; a fourth group, small land plants; and the fifth group centered its attention on the study of aquatic life, obtaining data from the brook which bordered the area.

—C.M.P.

KNOX, W. W. "Combination Laboratory for Small High Schools." *New York State Education* 20:538–539; 573; April, 1933.

Combination laboratory and classrooms are recommended as most adequately fulfilling the needs of present-day science teaching. The article includes drawings of two such combinations. One drawing is for a science room for a small high school. The second drawing is for a combination classroom and laboratory in a larger high school. Suggestions for equipping such rooms are included. —C.M.P.

CLARK, JOHN A. "Physics." *New York State Education* 20:532–533; April, 1933.

The author presents as the chief aim of science teaching the development of "science habits of thinking and acting." Specific aims for accomplishing this major aim include: (1) reliance upon fact rather than opinion; (2) intellectual honesty in acquiring facts and in the formation of judgments based upon them; (3) readiness to change opinion whenever facts are discovered.

In studying physics pupils need to take the objective approach if interest is to be sustained. Experiments should be experiences, not merely fact finding operations. More adequate preparation is needed by teachers if science is to be presented adequately. —C.M.P.

BENEDICT, RALPH C. "The Cultural Value of Biology in Secondary Education." *New York State Education* 20:530–531; 582–583; April, 1933.

The author presents the following as the chief values which biology makes to modern culture: (1) Biology contains a wealth of detailed facts which are capable of immediate application and value in the life of the individual (These come mainly under the heading of health facts; rules of hygiene, relating to food and air, to rest and exercise, to prevention of disease in the individual and in the social group.); (2) Biology contains important subject matter designed to develop social attitudes rather than individual ones (Here the author calls attention to the fact that the New York syllabus is based on what Dr. E. B. Wilson has stated as the two most important principles in biology: the cell doctrine and the evolution theory.); (3) Biology represents widening viewpoints, appreciations and understandings which are a natural consequence of an added knowledge of general principles. —C.M.P.

DINSMORE, E. L. "The Teaching of High School Chemistry." *New York State Education* 20:534; 583–584; April, 1933.

Some of the values to be derived from a study of chemistry are presented in this article. Brief attention is given to methods of teaching chemistry and to the importance of having an adequately prepared teacher. —C.M.P

GRAHAM, GRACE C. "Physiography in the High School." *New York State Education* 20:536; 584–585; April, 1933.

The author maintains that physiography should have a place among the specialized, high-school science courses. In support of this attitude, she quotes the *Thirty-First Yearbook* of the National Society for the Study of Education as listing thirty-eight objectives, nine of which are peculiarly within the province of physiography and are not fully developed in any other science.

—C.M.P.

Fowler, George W. "An Adventure in Chemistry." *New York State Education* 20:535; 579; April, 1933.

A project is carried out by three co-operating Syracuse high-school chemistry classes involving one hundred and fifty pupils and five teachers. The unit selected for study, "Our New Gas Supply," was particularly appropriate as Syracuse had recently made a change in its gas supply.

An outline of the plan used is included. Part One describes the teacher's part and Part Two describes the pupil's part. Brief consideration is given to values and objections to this method of teaching.

—C.M.P.

Francis, Raymond E. "A High School Plant Laboratory." *New York State Education* 20:540; 585–586; April, 1933.

The article describes the Benjamin Franklin Plant Laboratory, one of six similar plant greenhouses in the Rochester high schools. This particular laboratory is now sponsoring seventy-five individual projects, twelve group projects, six formal class projects, involving one hundred and eighty pupils, and a class observation set-up accommodating approximately sixty pupils per week.

There are two hundred and fifteen similar structures functioning in the secondary and elementary schools of other cities of the United States. —C.M.P.

Beery, Pauline G. "The Chemistry Leaflet and the Library." *The Chemistry Leaflet* 6:20–32; April 6, 1933.

The author presents an abbreviated index on the following topics: Air; Food; Water; Health; Shelter; Clothing; Ceramics, and Glassware; Pewter, and Modern Theories of the Structure of Matter. Following this topic index is a general index covering the first five volumes of *The Chemistry Leaflet.* (Science teachers, especially chemistry teachers, will find this index quite useful.)

—C.M.P.

Schuette, H. A. and Robinson, Francis J. "Ice Cream." *Journal of Chemical Education* 10:469–475; August, 1933.

The article outlines the evolution of ice cream from the iced beverages and the rich, frozen deserts of a bygone period to the scientifically compounded product of to-day. Typical recipes and current manufacturing processes are described.

—C.M.P.

Muskat, Irving E. "Chemical Exhibits at a Century of Progress." *Journal of Chemical Education* 10:387–390; July, 1933.

This illustrated article describes the exhibits in chemistry at the Century of Progress fair in Chicago. Other sciences have similar exhibits. —C.M.P.

Waggaman, William H. "Phosphate Rock Industry of the United States." *Journal of Chemical Education* 10:391–395; 476–483; July–August, 1933.

Part one of this article discusses the chemical nature, probable geological origin, and economic significance of phosphate minerals. Part two presents the chief methods of mining phosphate rock and preparing it for market. Illustrations are included.

—C.M.P.

New publications

ELLSWORTH, LINCOLN. *Search.* New York: Brewer, Warren and Putnam, 1932. 184 p. $4.00.

Even today the fire of exploration burns within the veins of many of us and of our students. We have all been interested in tales of the early explorers, but how much more thrilling to read the accounts of a real live explorer of today. In this book, entitled *Search*, Lincoln Ellsworth gives a personal account of modern exploration by decribing some of his own experiences and his part in making some of the discoveries of comparatively modern times. The chapters are "Westward," "The Last Buffalo Hunt," "Gold Dust," "Happy Hunting Trails," "War Birds," "Through the Andes," "Grand Canyon," "Ready for the First Polar Flight," "Air Pioneering in the Arctic," "An Epic of Polar Air Lanes," "Escape," "Over the North Pole," "Amundsen," "The Polar Basin Via Submarine," and "Zeppelin." It has a foreword by Gilbert Grosvenor and an introduction by Harold T. Clark.

—W. G. W.

MANN, PAUL B. and HASTINGS, GEORGE T., *Out of Doors.* Henry Holt and Company, 1932. 448 p. $2.00.

Out of Doors is an elementary guide to nature written for the use of young people, but, at the same time, it is a very helpful book for the teacher of elementary science. It is well illustrated and gives helpful directions for collecting and for preparing the materials collected. The book is packed with interesting information about animals, plants, the earth, and the sky. Some attention is given to fossils, the stars, and the weather. Several chapters dealing with "getting acquainted with nature in camp" are particularly fine. In this group are found "Nature Museums and Nature Trails," "Exploration," "Nature Games and Stories," "Nature Photography," and "Nature Study Equipment." The appendix has a key to summer and winter trees in addition to a brief outline of how plants and animals are classified.

—W. G. W.

HENDERSON, W. D. *Physics Laboratory Manual.* Chicago: Lyons and Carnahan, 1930. $1.00.

This is a separate-leaf manual giving outlines for 60 laboratory exercises in physics. It may be used with the author's *The New Physics in Everyday Life,* or with other current textbooks in physics. Each exercise states the object, lists the needed apparatus, gives the directions, supplies a record form for pupils' use, and includes some supplementary questions. Forty exercises are starred to indicate their use as a standard set covering about a year's work in physics. Twenty exercises are included for any supplementary use by teachers or pupils.

The exercises are prefaced by an introduction giving teacher and pupil suggestions and a list of apparatus for all exercises. The appendix includes some useful tables.

—A. W. H.

CUSHING, BURTON L. *Directed Studies for the Physics Laboratory.* Boston: Ginn and Company, 1932. 168 p. $0.76.

This is a new loose-leaf laboratory manual designed to supplement the text, *Phys-*

ics for Secondary Schools, by Stewart, Cushing, and Towne. Sixty experiments are grouped under twenty-four topics particularly to direct attention to large unifying principles of physics. At the end of each topic are given some exercises under the heading of "Topic Conclusion."

—A. W. H.

DUFF, A. WILMER et al. *Physics.* Philadelphia: P. Blakiston's Son and Company, 1932. 681 p. $4.00.

This is the seventh revised edition of the book originally written by seven teachers of college physics. Two additional teachers of college physics are represented in the seventh edition.

The treatment is strictly conventional in order, not overly mathematical, and is supplemented by many illustrative problems and references. It is intended as an introductory college course for students of science and engineering. —A. W. H.

SEARS, FREDERICK E. *Essentials of Physics.* Laurel Book Company, 1931. 583 p. $1.32.

This is a second edition of the text with some revisions of former chapters especially the chapter on "X-rays and Radio Activity." An additional chapter, "Additional Applications and Recent Developments in Modern Physics" serves particularly to bring the book up-to-date.

It is difficult to evaluate the book without having used it in instruction. In keeping with most textbooks of physics, it follows the conventional order of treatment. Its emphasis on the historical background and the last chapter mentioned above make it different. It is attractively printed, has a wealth of illustration, includes many questions and problems, gives a summary at the end of each chapter, and suggests some subjects for additional study at convenient intervals. It compares favorably with other current texts and should prove a satisfactory book for pupils in the secondary school. —A. W. H.

SEARS, FREDERICK E. *Laboratory Manual of Physics.* New York: Laurel Book Company, 1931. 152 p. $0.66.

A revised edition of the author's manual. It includes sixty-one experiments in looseleaf form, consisting of standard experiments and some new experiments. It is intended especially as a supplement for the author's textbook in physics.

—A. W. H.

GUY, J. SAMUEL and SKEEN, AUGUSTA. *A Course in Quantitative Analysis.* Boston: Ginn and Company, 1932. 242 p. $2.20.

This book is intended as a text for a beginning course in quantitative analysis. The introductory sections deal with an outline of chemical theories and the use of the apparatus recommended for work in analysis. Part I of the text proper deals with volumetric analysis, Part II with gravimetric analysis, and Part III with hydrogen ion determination.

In the course the emphasis is placed upon volumetric analysis and this division is placed first in the organization. Early experiments are chosen so that the students may carry them through without too many difficulties. Gravimetric analyses are selected which will illustrate the different types of procedures to be used.

The amount of subject matter contained in the text is not large. Teachers looking for a reference work on analysis must look elsewhere. The organization of materials would seem to give fine promise for good teaching results. The book is recommended for serious consideration to teachers handling elementary courses in quantitative analysis. —R. K. W.

KIPPING, F. STANLEY, and KIPPING, F. BARRY. *Organic Chemistry.* Philadelphia: J. B. Lippincott Company, 1932. 613 p. $3.50.

This college text is a revision of the old standard authoritative text by Perkin and Kipping, first published in 1894. Other revisions were made in 1902, 1911, and 1922. The present edition is not only brought up-to-date but largely rewritten. This volume is Part I of the complete work.

Those familiar with the field of organic chemistry are aware, of course, that the authors are British and that the general tone and organization of the text is largely

determined by English conditions. A peculiar pedagogical arrangement for American readers is to be found in the setting of the material for an elementary course in large type and the material for a more advanced course in finer type interspersed throughout the original text. Students doing only a semester's work are expected to use the material in large type. Those continuing with the work are expected to go back through the book and use both the material in large type and that in fine type. In the words of the authors, those desiring a "pass degree" use the large type passages, those "reading for honors" use all the material.

American high-school teachers of chemistry will find here an authoritative reference work for the library.

—R. K. W.

Huxley, Julian S. *Problems of Relative Growth*. New York: Lincoln MacVeigh (The Dial Press) Inc., 1932. 296 p. $3.50.

This book gives the result of ten years of study of the relative growth of parts in animals and correlates these findings with those of other workers. The new things brought out are the quantitive formulation of heterogonic growth; the discovery of widespread existence of growth-gradients; the recognition that growth of logarithmic spiral type, as seen in molluscan shells, operates with the same growth-mechanisms as does the ordinary type as seen in a sheep's leg; the application of these results to certain evolutionary problems. The scope of the book is well indicated by the following chapter titles: "Constant Differential Growth-ratios," "The Coefficient of Constant Growth Partition and Some Special Cases," "Growth-centers and Growth-gradients," "Growth-gradients and the General Distribution of Growth Potential in the Animal Body," "Growth-centers and Growth-gradients in Accretionary Growth," "Heterogony," "Growth-gradients and Physiology," "Bearings of the Study of Relative Growth on Other Branches of Biology." —W. G. W.

Philip, George and Finch, V. C. *Standard School Atlas*. New York: D. Appleton Company, 1932. 63 p. $1.50.

A large amount of information in a small space will describe this atlas. Twenty-eight preliminary pages explain the atlas, the character of maps, and how to interpret maps. This is very helpful material for all atlas users to know. The chief types of maps are political, physical, temperature and rainfall, vegetation and soils, and population. Tables of areas and populations of the principal countries of the world and population of the principal cities are given. —W. G. W.

Soddy, Frederick. *The Interpretation of the Atom*. New York: G. P. Putnam's Sons, 1932. 356 p. $5.00.

Since 1895, 1896 and 1897 when X-rays, radioactivity, and the electron were respectively discovered and recognized, there has been a progressive advance in knowledge of the fundamental nature of matter. During this period theories of atoms and atomic structure have passed through a variety of changes. Science teachers and college students will find this authoritative work by Soddy extremely interesting, remarkably clear, devoid of difficult technicalities, and complete. Unusual halftones and line cuts add much to the value of the book.

Part one, "The Radioactive Elements and Isotopes," discusses these topics: "The Discovery and the Interpretation of Radioactivity"; "Isotopes"; "Helium and Radioactivity"; "The Uranium Disintegration Series"; "Radium and Radon"; "Alpha-rays, Beta-rays, Gamma-rays and X-Rays"; "Thorium and Actinium Disintegration Series"; "The Active Deposits"; "The End of the Disintegration Series." Part two, "The General Progress of Atomic Chemistry," takes up these topics: "Matter and Electricity"; "Theory of Relativity"; "Structure and Spectrum of the Atom"; "Quantum Theory"; "The Periodic Table"; "Chemical Affinity"; "The Enumeration of Molecules and Atoms"; "The Atomic Nucleus"; "The Isotopes of the Inactive Elements"; "Radioactivity and the Universe"; "Cosmical Rays." —W. G. W.

Ehrenfeld, Louis. *The Story of Common Things*. New York: Minton, Balch & Company, 1932. 203 p. $2.50.

This is a book for the high-school-science library. The "common things" are treated from the point of view of chemistry. Alone, the book does not give a comprehension of basic concepts of chemistry. The material is treated largely from a descriptive point of view. In connection with other science material, general science or high-school chemistry, it should do much to help pupils interpret the things immediately around them. Topics treated are matches, paper, glass, soap, fertilizers, synthetic products made from milk, antiseptics, anaesthetics, salt, sugar, common metals, phenol compounds, and ceramics.

The material may be read by junior-high-school pupils and is interesting reading for the adult. Descriptions are brief and should lead to a desire for further reading on the same topics. Teachers should consider this book in building up new library lists for purchase.

—R. K. W.

McHale, Kathryn, *et al.* The Thirty-First Yearbook of the National Society for the Study of Education, Part II. *Changes and Experiments in Liberal-Arts Education.* Bloomington, Illinois: Public School Publishing Company, 1932. 267 p. $1.75.

This yearbook of the National Society is devoted to the report of the American Association of University Women's Coöperative Study of Changes and Experiments in Liberal-Arts Education. Major divisions of the study are found under the following headings: "Current Changes and Experiments"; "Major Phases of Experimental Change with Illustrations"; "College Ventures in the Stimulation of Intellectual Life"; "American and English College Practices"; "Notes on the Technique of Experimentation in a Liberal Arts College"; "Liberalizing a Liberal Education"; "Future Possibilities in Liberal Arts Education," and "Bibliography."

To those who may have believed that the liberal arts colleges have been carrying on in a pattern of traditionalism uninfluenced by the changes about them, the description of the one-hundred and twenty-eight changes in Chapter III will come as a revelation. Those looking for scientifically evaluated and measured results produced by changes in practices of liberal-arts colleges will be disappointed.

Altogether the report is just what it purports to be, a description of those changes and experiments now going on in the liberal arts colleges of the country. Its reading is recommended to administrators and teachers now working in colleges and to graduates of colleges of the past ten years or more. —R. K. W.

Cleland, Herdman Fitzgerald. *Geology, Physical and Historical, Part II. Historical.* New York: American Book Company, 1929. 702 p. $2.40.

This text is available in a one-volume and two-volume edition. This book is volume two of the two-volume edition and is intended as a text for colleges dividing the work in geology into two one semester courses. The general scheme is a broad outline of the history of life on the earth from the evolutionist's point of view. The divisions follow the chronology of geological periods, pre-cambrian, cambrian, ordovician, silurian, devonian, carboniferous, mezoic, and cenozoic.

The material is developed in such a way as to hold the interest of the student and there is much that a lay reader may get from it. Illustrations are many and well placed. The high-school teacher of science will find much useful reference material, especially in those sections beginning with the carboniferous periods and following on through the age of reptiles and the age of mammals. —R. K. W.

Gates, Arthur I.; Mort, Paul R.; Symonds, Percival M.; Spence, Ralph B.; Craig, Gerald S.; Stull, DeForest; Hatch, Roy; Shaw, Amy I.; and Krieger, Laura B. *The Modern School Achievement Tests.* New York: Bureau of Publications, Teachers College, Columbia University, 1931. 31 p. $0.35.

This is a battery of achievement tests grouped into a general grade-school achievement test. Its function is similar to the widely used *Stanford Achievement Tests.* Tests included are: reading comprehension, reading speed, arithmetic computation, arithmetic reasoning, spelling,

health knowledge, language usage, social studies, and elementary science. Reliability as given by the authors is from .67 to .96 for the several tests and for the battery for a single grade from .94 to .97.

Age norms in years and months and grade norms are printed on each test. Norms were established by administering the tests to 6,710 children in 37 cities.

The inside of the cover page provides a data sheet for recording personal and social data concerning individual cases. It is expected that the data are to be used in conjunction with evidence gained from the use of the tests. —R. K. W.

PHILLIPS, WENDELL CHRISTOPHER, M.D., and ROWELL, HUGH GRANT, M.D. *Your Hearing*. New York: D. Appleton and Company, 1932. 232 p. $2.00.

This book is written by two physicians, both engaged in educational work, for the benefit of those who are or who are likely to become hard of hearing. It includes sixteen chapters on the structure of the hearing organs, hygiene of hearing, testing hearing, and aids and suggestions for the hard of hearing. The last chapter gives some explanations of how racketeers prey upon the hard of hearing. It is written primarily in the interests of the nearly twenty million of our population who belong to this group, but obviously is valuable for any person. The great amount of attention given to the 57,084 deaf mutes in this country is contrasted with the relatively much less attention which has been given to the large fraction of our population found to be hard of hearing. Only recently, due to the accurate testing devices invented, have we discovered the vast extent of hearing difficulties.

The book is written in an easy style suitable for the layman. It is a useful book for any library. —A. W. H.

MURPHY, GARDNER, and JENSEN, FRIEDRICH. *Approaches to Personality*. New York: Coward-McCann Inc., 1932. 427 p. $3.75.

This book is written by a psychologist and a psychiatrist coöperating. It is planned for the student or educated layman who wishes to get an orientation regarding the attitudes of various psychologies to the problems of personality. Part I is devoted to experimental psychology. Chapter I discusses the viewpoint of the Gestalt psychologists; Chapter II, that of the introspectionists and associationists; and Chapter III, that of the behaviorists.

Part II is concerned more particularly with the psychiatric aspects. Chapter IV discusses the psychoanalysis of Freud; Chapter V, the analytic psychology of Jung; and Chapter VI, the individual psychology of Adler.

Part III discusses the genetic aspects. Chapter VII, contributed by Dr. John Levy, presents the child guidance approach to personality. Chapter VIII concludes the book with a consideration of eclecticism. Here are stated the problems which must be attacked experimentally before personality can be better understood.

The book is scholarly, not a superficial popular treatment. The language, however, is not overly technical.

—A. W. H.

MILLER, CARL W. *An Introduction to Physical Science*. New York: John Wiley and Sons, 1932. 403 p. $3.00.

This is a college textbook which attempts a survey of physics with mathematical explanations limited to the difficulty of high school mathematics. The first chapter discusses the development of the scientific method from its beginnings in man's curiosity about the starry heavens and other features of his environment, to the discovery and use of the experimental method by Galileo. From this dawn of physical science the remainder of the book follows a rather conventional order beginning with mechanics and leading to a study of some of the latest concepts of relativity, the quantum theory, modern wave mechanics, and cosmic physics.

Thirty-eight chapters are included in the book. Chapters twelve and thirteen introduce the student to a sufficient knowledge of elementary chemistry to prepare the way for the later discussions of the quantum theory and wave mechanics. Historical continuity and the conventional order of physics are the primary means of securing coherence in the book as a whole. In general

the author has not attempted to organize the subject matter otherwise than in the usual sequence. The lack of integration around a small number of major concepts, and the large number of separate chapters tend to break it up into relatively small divisions with little emphasis on the connections between them.

From the viewpoint of difficulty the book appears to be especially well adapted to the capacities of students taking a first, or survey, course in physics. —A.W.H.

LOEB, LEONARD D., and ADAMS, ARTHUR S. *The Development of Physical Thought.* New York: John Wiley and Sons, 1933. 648 p. $3.75.

This book is a pioneer in the field of survey courses in modern physics. While utilizing a minimum of mathematical treatment—indeed involving only elementary algebra and geometry—the book is scholarly enough for minds of collegiate caliber, and not to be thought of as a superficial or popular presentation. The plan is fundamentally historical with intent to show how man's conception of the physical universe has changed as his curiosity has led him to make new discoveries. Experimentation as a useful tool, and generalization and integration as powerful thought processes are clearly exemplified in the book. The method of science is of primary consideration in the minds of the authors, and they are greatly concerned with the modern concepts of physics which have been the fruits of this method.

After an historical introduction showing the origins of scientific thought, the main divisions are mechanics, heat and the structure of matter, electricity and magnetism, light, and the electrical structure of matter and the new physics. The last division receives the greatest emphasis judged by the number of pages given to it, with mechanics a close second. The subject of light receives 27 pages, and sound is not included.

The book should be especially welcomed as a textbook example of departure from the exclusively conventional texts so universally used, and the introduction of a type which promises much utility to persons desiring a survey treatment.

—A.W.H.

HANS REICHENBACH. *Atom and Cosmos.* New York: The Macmillan Company, 1933. 300 p. $2.00.

In this book, the author has attempted to give the non-specialist a glimpse of the world of the specialist who is delving into the mysteries of physics. Physics has succeeded so well in surrounding itself with a "hard shell of special terms" that the layman is apt to think that "it is an affair of the learned alone."

In non-mathematical language, the author explains the modern conceptions of (1) *Space and Time*, (2) *Light and Radiation*, (3) *Matter*, and (4) some *Philosophical Consequences* of these new conceptions.

—A.W.H.

DEPARTMENT OF SUPERINTENDENCE. Tenth Yearbook. *Character Education.* Washington, D.C. The Department of Superintendence of the National Education Association. 1932. 404 p.

A report on character education has been prepared by a commission of nine distinguished men, including superintendents, principals, supervisors, and professors of education, appointed by the Department of Superintendence. It is a composite work in which no part is credited to the authorship of any individual. In general, the report may be described as a rather exhaustive and scholarly survey of the possibilities of education for character as these may be found in the school. Careful use is made of the scientific and theoretical literature of the subject, and valuable bibliographies are given with several chapters.

The first four chapters on American life and the agencies, objectives, and theory of character education are introductory in nature. Chapter V on Research Related to Character Education, offers excellent digests of ninety-five superior representative investigations classified under six heads. The next ten chapters set forth the relationship of character education to such component factors of the school as the curriculum, classroom procedure, sex training, student organizations, counseling, administration, and the teacher. In each of these chapters opportunities for practical application are stressed. In the sixteenth and final chapter the value and use of a substantial

number of typical tests and other measuring instruments are carefully set forth.

The entire work is a veritable mine of information on character training. While somewhat technical in treatment the book might well be considered for textbook use by teachers of courses in this field. It is indispensable to any school man who proposes to do serious work on the subject.

—PAUL W. TERRY
University, Ala.

HALDANE, J. B. S. *The Causes of Evolution.* New York: Harper and Brothers. 235 p. $2.50.

In *The Causes of Evolution* the author places emphasis upon the causes of the process of evolution, rather than a description of the process itself. He assumes that the reader has accepted the theory of evolution and that he is in a general way familiar with it. The author undertakes to answer the following questions: "What is the nature of the heritable differences within a species? Are the differences between species of the same or of a different character? Does selection really occur in nature? Will it account for the formation of species? Must we allow for other causes of evolutionary change? Is the process of evolution good or bad, beautiful or ugly, directed or undirected?"

These questions are approached from the standpoint of the geneticist, but no previous knowledge of genetics is required to understand the presentation. The mathematical treatment involving the probability of mutation and its preservation through selection is unusually interesting. For those who wish to follow this phase of the subject, there is a forty-four page appendix in which it is outlined in some detail.

As in other books, Mr. Haldane becomes philosophical in places, particularly in the concluding chapters. He, however, recognizes that when he does so he is no longer scientific, but believes that a philosophical treatment is desirable for the human interest values suggested by the last question quoted above.

On the whole this is a very readable and interesting book.

—AUSTIN D. BOND
Alfred University,
Alfred, New York

GREGG, F. M., and ROWELL, H. G. Health Studies (2 vols.): *Personal Health.* 310 p. $0.84. *Home and Community.* New York: World Book Company, 1932. 253 p. $0.76.

These two books, the one covering a health program from the point of view of the individual and the other from that of the community, have organized the accepted subject-matter for junior high school health courses into a series of units which emphasize self-activity on the part of the pupil. They are far more than mere books of information. The leading questions and suggested problems for investigation should lead, under the hand of a skilled teacher, to real accomplishment and genuine interest on the part of the pupil. An apparently successful attempt has been made to produce a textbook consistent with the modern theory and philosophy of education. Teacher's manuals are available. As the reviewer is not an expert in the field of physical education he is not competent to judge of the validity of the selection and organization of the material, but the experience and position of the authors should be good warrant for the assumption that this is satisfactory.

There is a certain looseness in the use of words, particularly in *Personal Health.* The term "power," for example, is used loosely in its literary sense, in conjunction with an exact definition of energy. Thus we have energy defined as "the power that makes things move." Again, it is a bit more exact to consider that sound waves move away from the source of disturbance in spheres rather than "rings." The reviewer prefers to describe yeast cells as oval rather than "oblong" although the dictionary definition of the latter word does not make such use of it incorrect. In preparing pulpwood for paper-making the logs are not "chipped into small pieces by being pressed against a grindstone." Such a statement as "The unit used in measuring food is the calorie . . ." seems unnecessary even though it is followed by a correct definition of the calorie in the same sentence. It also rubs the reviewer the wrong way to see the Calorie defined as the amount of heat required to raise one pound of water 4° Fahrenheit, particularly when the distinction

between calorie and Calorie is not made. However, these are small matters, and perhaps unimportant.

The treatment of tobacco and alcohol is much more reasonable than that found in many of the health texts, although even here there is some slight use of unscientific experiment and of what seems to the reviewer unwarranted conclusions from research on the subject. The usual comparison of grades of smokers and non-smokers is made with due consideration of common selective factors which may be the source of both the low grades and the smoking, and the correlation is of low ranks with those who "smoked a great deal." With this statement "however" is one to the effect that of a certain college group who were dropped from their classes 88 per cent were smokers. It would be interesting to compare the percentage who were not dropped from their classes and who were smokers. One experiment involves the comparison of two guinea pigs or white rats, one being given milk to drink and the other a sweetened patent medicine containing alcohol. As a previous experiment has already shown that absence of milk will cause certain deficiencies in growth how is one to determine in this case what to attribute to the presence of alcohol and what to absence of milk? Are we to assume that because alcohol poured on the white of egg coagulates it, that alcoholic beverages produce their harmful effects in the same manner? What will be the effect on a youngster to tell him that cigarette smoke contains four poisonous substances (carbon monoxide, prussic acid, furfural and nicotine) when he sees such a large percentage of the population, male and female, indulging? The reviewer believes that the facts as they exist, will be more effective in producing an attitude of temperance in these matters than they will over eager efforts to prove the point. Then too, it gives an over-simplified idea as to what real scientific research is. There is a considerable amount of reasoning by analogy, of drawing conclusions when only a few of a number of variables are controlled, and of assuming cause and effect relationships between two events merely because they occur at the same time to be found in the science materials which are being presented to children.

—O. E. Underhill

National Research Council Bulletins. *Physics of the Earth.* Published by the National Research Council of the National Academy of Sciences. 1931–1932.

I. Volcanology. No. 77. 67 p. $1.00
II. The Figure of the Earth. No. 78. 277 p. $3.50
IV. The Age of The Earth. No. 80. 466 p. $5.00.
V. Oceanography. No. 85. 557 p. $5.00.

This series of Bulletins probably represents the best and most authentic survey of the fields represented that can be found. Issued as part of a program of geophysical investigation having its origins six years ago, it has been carried on by a series of committees, the members of which are the leading specialists in each particular field. These books are highly technical, and although they have been written for those outside the particular fields with which they deal, they are intended for the trained scientist. They will not prove easy reading to the average high school science teacher but they should be extremely valuable as an authentic reference work in the school library, and they will furnish much valuable classroom material if the teacher is willing to do the hard work necessary to dig it out and put it in usable form.

A list of the table of contents will indicate the scope.

I. Volcanology. 1. Volcanoes, Their Activity and Their Causes 2. The Present Condition and the Future of Volcanology 3. The Mechanism of Volcanoes.

II. The Figure of the Earth. Part I (six chapters) Tides, Ocean and Earth; Part II (9 chapters) Gravity, Deflection of the Vertical, and Isostacy; Part III (1 chapter) Variation of Latitude.

IV. The Age of the Earth. Summary of Principle Results (7 p.); Part I Geochronology, or the Age of the Earth on the Basis of Sediments and Life (55 p.); Part II Age of the Ocean (8 p.); Part III Calculating the Age of Minerals from Radioactivity Data and Principles (51 p.); Part IV Radioactivity and Geologic Time (336

p.); Part V The Age of the Earth from Astronomical Data (7 p.)

V. Oceanography. Part I Introduction (1 chapter) The Domain of Oceanography; Part II (2 chapters) Bottom of the Ocean; Part III (2 chapters) Properties of Sea Water; Part IV (5 chapters) Movements of Sea Water; Part V (3 chapters) Oceanographic Instruments; Part VI (3 chapters) Relations of Oceanography to the Other Sciences. —O. E. UNDERHILL

ROGERS, STANLEY. *The Pacific*. New York: Thomas Y. Crowell Company, 1930. 248 p. $2.75.

If one wishes to read the story of the Pacific Ocean, of its islands and their strange inhabitants, of historical voyages, of merchant shipping, of authors who fell under its spell, of shipwrecks and adventures, "The Pacific" is an attractive volume for that purpose. In view of the prophecy that the Pacific will be the future chief highway of commerce as the Atlantic has been in the past, it behooves one to know something of its places and peoples, its romance and tragedy, its opportunities and disillusionments.

This book is more suitable for a student or reader in social science than natural science although there is some discussion of wind currents, fauna and flora, and the origin of land and peoples.

The author writes in an easy and friendly manner, he is enthusiastic about his subject, and has gathered much interesting information. He has lavishly illustrated the book with his own sketches and maps. There are appropriate scenes heading each chapter and many delightful pen and ink sketches of ships, isles and people. Very useful maps adorn the inside of the front and back covers. —O. E. UNDERHILL

HAMBLY, WILFRED DYSON. *With a Motor Truck in West Africa*. New York: The Century Company, 1931. 259 p. $2.00.

The author describes his adventures in leading a scientific expedition through thousands of miles of jungle, swamp and desert into Angola, Portuguese West Africa and Nigeria in order to obtain specimens for the Field Museum of Chicago. The first quality which the teacher looks for in travel books is accuracy. Mr. Hambly's experience and position should guarantee the truthfulness of this narrative, and its correctness is further certified to in the introduction by Delia (Mrs. Carl) Akeley.

Although it is written especially for young readers, being described on the jacket as *A Travel Adventure Book for Boys*, it is in no sense "written down" and should prove of interest to anyone, boy or girl, young or old, who likes to read about far distant places. Its style is direct and pleasing, and it gives the sort of information about the incidents of the trip and the lives of the natives that is of most interest to the vicarious traveler. —O. E. UNDERHILL

MORDANT, ELINOR, *Rich Tapestry*. Farrar and Rinehart Inc. New York: 1932. 290 p. $3.50.

The author, a much traveled English woman who has written several other books of travel, paints a series of word pictures of her most recent wanderings. Three portions of the globe are visited. First to Havana, then into Central America through Guatemala and Quetzaltenango, returning by way of San Salvador, Amaplia, Tegucigalpa, San Pedro and Tella, and thence by boat to New Orleans, visiting a circus rest camp and a Negro church in Florida en route. Another series of sketches describes incidents on a journey through Equatorial Africa, starting from Mombasa northwestwardly through the Kenya Colony to the Nile, following it northwards through the Uganda to the edge of the Sudan, back to the equator and thence southwestwardly through the Belgian Congo. Finally she visits the Orient which she imaginatively describes.

The author makes of the many minor details of travel a fascinating and interesting story. She travels among the by-ways rather than on the highways, and her adventures in obtaining food, shelter and transportation in out-of-the-way places provide many scenes to be woven into the "rich tapestry" of her memories. Her skill in weaving this tapestry with words results in a thoroughly delightful book.

—O. E. UNDERHILL

REAGAN, G. W. *Fundamentals of Teaching.* Chicago: Scott, Foresman and Company, 1932. 543 p. $2.12.

Although this is a textbook of general method it is of interest to teachers of science for two reasons. First, it uses many examples from the field of science as illustrative material and as suggested pupil activity. Second, it puts rather definite emphasis on the development of scientific methods of thinking through school procedures.

A lesson on the formation of dew is developed in order to show how specific objectives may be formulated, and to show their value in determining teaching procedures. The chapter dealing with problem solving will prove suggestive to the science teacher in many ways. A detailed analysis is given of the preparation of a lesson plan on the topic "The Lever" for an eighth grade or ninth grade general science class. It is perhaps not a fortunate selection, as the result seems to be a rather formal catechism type of lesson, emphasizing rather more of the technical physics than would probably be considered desirable by many teachers of general science.

Although the science teacher may question the suitability of some of the suggested procedures here and there, the generalized treatment of method should prove very thought provoking, and should stimulate the science teacher to move from the general to the specific by attempting to apply the general procedures set forth to his own subject matter.

—O. E. UNDERHILL

WEED, HENRY I. and REXFORD, FRANK A. *Useful Science.* Book II. Philadelphia: The John Winston Company, 1931. 435 p.

A junior high school text which covers the traditional general science material. Good questions for directed study are given in several chapters. The illustrations and the format are very pleasing. Directions for experiments are inserted as the need develops. The text will appeal most to the teacher who wishes to do his own motivation and who desires in a text a straightforward presentation of information without the suggested teaching devices which have characterized most of the General Science texts of the last few years.

—O. E. UNDERHILL

EMERY, FREDERICK B., MILLER, ELIZABETH W. and BOYNTON, CHARLES E. *Applied Chemistry.* Chicago: Lyons and Carnahan, 1928.

The manual contains directions for 120 experiments. The student "writes up" the experiments by filling in blanks. Part I contains fifty-three general experiments on non-metals and metals, and a dozen special supplementary experiments. Part II contains fifty-two food experiments intended chiefly for girls studying domestic science. Part III contains a brief system of inorganic analysis.

There are a number of interesting experiments and variations not found in the usual chemistry laboratory manual. Preliminary directions include pictures of the various pieces of apparatus, methods of weighing, and methods of working glass.

—O. E. UNDERHILL

DINSMORE, ERNEST L. *Chemistry for Secondary Schools.* Chicago: Laurel Book Company, 1931. 566 p. $1.26.

A revision of the 1925 text, brought up to date in the matter of atomic structure. The author, in the preface, gives his point of view as follows:

"The author's observations have led him to believe that the training needed for college is the same as that required for industrial pursuits and other walks of life. For that reason the fundamentals have not been neglected in this book."

—O. E. UNDERHILL

DINSMORE, ERNEST L. *Laboratory Manual of Chemistry.* Chicago: Laurel Book Company, 1931. 164 p. $2.00.

A manual to accompany the text reviewed above. The manual contains 75 experiments, giving directions and guiding questions. It is intended that the student write out his observations and answers to the questions separately from the manual.

—O. E. UNDERHILL

FOWLER, GEORGE W. and KANE, EMMET P. *Mastery Tests in Chemistry.* Boston: Ginn and Company, 1932.

Thirteen units of four pages each covering the traditional chemistry material. One-word recall, multiple-choice, matching, completion and modified true-false forms are used. —O. E. UNDERHILL

HESSLER, JOHN C. *The First Year of Chemistry*. New York: Benj. H. Sanborn and Company, 1931. 544 p. $1.68.

The author, according to his preface, has attempted to present that material which must be covered in order to meet the present college standards as to what a first course in chemistry should be, and at the same time to justify the science to those who will, in all probability, not study this science further. In the reviewer's opinion this is an almost impossible task. However, the attempt to do this has resulted in a much more readable text than many of the high school texts of the past. Nevertheless it is the traditional, logically organized freshman college chemistry course for science majors, on a secondary level. This is not a criticism of this text, but of the high school chemistry set-up which makes it necessary to give a course designed for students who intend to become scientists, to those who should be studying science as part of a liberal education rather than as preparatory to further science work.

The style of this text is simple, clear and interesting. The ideas seem to be developed one after the other, gradually building from simple experiences to more complex concepts. More than usual care seems to have been taken with the illustrations, which, with their accompanying captions, contribute definitely to the learning process. —O. E. UNDERHILL

BRADBURY, G. M. and MCGILL, M. V. *The 20th Century Practice-exercises and Objective Tests in Chemistry*. Fowler, Indiana: The Benton Review Shop, 1931. 132 p. $.25.

The traditional high school chemistry course is divided into thirty-two "units"; one or two "practice-exercises" and a "unit test" are provided for each. Page references to six of the more popular chemistry texts are given for each unit. The student is to do a practice-exercise after he has covered the work in class, score his own exercise, and then use it as a basis for review work. After one or two such exercises, the "unit test" is given. It is expected that the pupil should obtain a perfect score. Any items missed are to be re-reviewed. It is suggested that the instructor construct his final examinations from questions most often missed from the unit tests. The items are mostly of the completion or some other form of the recall type. A teacher's answer book is provided. —O. E. UNDERHILL

ROBINSON, W. W. *Beasts of the Tar Pits*. New York: The Macmillan Company, 1932. 46 p. $1.75.

This is another of those interesting books for children which have of late been increasing rapidly in number, as more and more writers and artists who have been successful in other fields, have given their attention to the task of presenting authentic information in a manner attractive to children. It tells the story of the animals of the Pleistocene age as reconstructed from the bones found in the La Brea tar Pits, now part of a park in the city of Los Angeles. A page or two is given to each of ten prehistoric forms, such as the mammoth, the saber-tooth, and the giant sloth. Each is illustrated with a full page sketch by Mrs. Irene B. Robinson, wife of the author, and a western artist who has been painting and exhibiting for several years. The book as a whole gives a definite and clear impression of the tragedy of the asphalt, and the type of life of the period. It could be used at about the fourth grade level and would be particularly useful where units dealing with prehistoric life are developed. The type is rather small and monotonous for very young readers. —O. E. UNDERHILL

LENT, HENRY B. *Diggers and Builders*. New York: The Macmillan Company, 1931. 68 p. $2.00.

This book for children tells in a simple and straightforward way the stories of Tony, with the Steam-shovel; Sam, the Cement Mixer; Dan, the Derrick Man; Joe, the Steel Worker; Pedro, the Road Builder; and Bill, the Truck Driver. The style is delightfully free and interesting, without the least trace of "writing down" for children. The black and white illustrations by the

author are most excellent, the silhouette portraits of the various types of workmen being quite characteristic.

These sketches can be read understandingly by third grade children. The material in *Diggers and Builders* might well be made the focal point from which to branch out along both social science and natural science lines. —O. E. UNDERHILL

BRONSON, WILFRED S. *Paddlewings—The Penguin of Galapagos*. New York: The Macmillan Co., 1931. 106 p. $2.00.

The author of *Fingerfins* has written another charmingly humorous and at the same time authentic nature book for children. Mr. Bronson has been studying and painting marine animals for many years. While with an expedition to the Galapagos Islands collecting specimens for the New York Aquarium, Natural History Museum and Zoo, he selected the Penguin as the hero of his second book. He weaves into this narrative of the penguin's life and travels an interesting account of the origin of these volcanic islands, a brief survey of the development of the higher forms of life from the single cell, and many well-handled examples of adaptation to environmental change. The humor of his drawings makes them doubly attractive. His fondness for analogy perhaps leads to some confusion as to when such analogies are mere humor and when they are real relationships.

The personification is handled in such a manner as to be satisfactory to the most meticulous scientist, yet the light imaginative touch which is so charming to children has not been lost. For example,

"His wish to fly was stronger than ever before and it made him sad. Not that he really thought about it, but he felt defeated . . ."

and again

". . . he stretched himself, hungry and worried. I won't say he thought 'Oh dear, I wish I knew where my parents are' but he missed them just the same; and he didn't say to himself 'I do wish a thunderstorm would come' but he would have been very glad of a change in the weather."

The Bronson books could probably be read by children who were up to standards of third grade achievement and would certainly be suitable for reading by children of fourth grade and upwards. Much of the material could be used advantageously even in the second grade if read by the teacher. The reviewer believes that there is no upper age limit to the enjoyment of these amusing and interesting stories.

—O. E. UNDERHILL

BRONSON, WILFRED S. *Polliwiggle's Progress*. New York: The Macmillan Company, 1932. 122 p. $2.00.

What has been said in general about the Bronson books in the review of *Paddlewings* is true also of *Polliwiggle's Progress*. The career of an individual bullfrog Pollywog is followed from the mating of its parents to its complete maturity some two years later. Interesting stories of many other forms of life weave themselves into the biography of Polliwiggle, beetles, dragon-flies, damsel-flies and their larva; bitterns, snakes, skunks and many other forms of life, to say nothing of Farmer Guss and Fat McWerter, who are some of Polliwiggle's neighbors. The old quarry pond, from a frog's-eye view, takes on forms quite strange to our customary angle of vision. The view of the bittern from the legs up, and of the herd of cows as seen from below the surface of the pond in which they are wading are as interesting, as the point of view is unusual. Like *Fingerfins* and *Paddlewings*, *Polliwiggle's Progress* has range of interest of from eight to eighty years.

—O. E. UNDERHILL

BOCK, GEORGE E. *What Makes the Wheels go Around*. New York: The Macmillan Company, 1931. $2.00.

This book will answer for many high-school children some of the questions that they ask about machines. The content of the book covers a large number of subjects in very elementary manner, such as machines, levers, gears, inertia, power, wind, energy, boilers, steam engines, turbines and automotive engines. The illustrations are unique in character and assist greatly in illustrating many of the scientific principles. The artist has done some clever work in attempting to explain these physical principles through illustrations.

The book is designed as a supplementary book for general science and physics.
—G.S.C.

KENLY, JULIE CLOSSON. *Children of a Star.* New York: D. Appleton and Company, 1932. 238 p. $2.50.

The author has attempted to write about living things for children. There is a rather wide range of topics. The book may be used as supplementary material in intermediate and junior high school grades. —G.S.C.

THOMAS, ROY H. *Living Things Around Us.* Philadelphia: J. B. Lippincott and Company, 1928. 200 p. $.76.

The author has written this volume for the purpose of giving boys and girls a better acquaintance, understanding, knowledge and appreciation of the workings and mysteries of nature, and to start them toward the keen enjoyment of life that springs from companionship with its elements.

The book is designed as a "nature study-agriculture science reader." The stories consist largely of experiences of a boy named Sammy and his teacher. Some of the content treated is soil formation, seeds, underground storehouses, fertilizers, bacteria, insects, birds, agricultural problems.
—G.S.C.

HAWKS, ELLISON, *The Romance of the Merchant Ship.* New York: Thomas Y. Crowell Company, 1931. 320 p. $3.00.

Teachers have seized upon the natural interest of children in boats to introduce the study of water transportation in the natural and social sciences. This book gives the story of ships from the "dug-out" to the modern steamship. Other topics that are treated are: (1) the building of a ship; (2) finding one's way at sea; (3) how a ship is navigated. —G.S.C.

SNOW, LAURA G. *Music and the Out-of-Doors.* Ithaca, New York: The Slingerland-Comstock Company, 1930. 84 p. $1.00.

This book is designed for nature guides and others that are interested in the correlation of nature study and music. The author discusses music as an aid to nature education, primitive music and musical instruments and the contributions that have been made to music by various peoples.
—G.S.C.

SHENTON, EDWARD. *Couriers of the Clouds.* Philadelphia: McCrae Smith Company, 1930. 202 p. $2.50.

This book may be considered a story of the air mail rather than a science book. Children can gain an impression as to the duties of a mail pilot, and how the air mail service is organized and maintained.
—G.S.C.

JONES, PAUL. *An Alphabet of Aviation.* Philadelphia: McCrae Smith Company, 1928. 60 p. $2.00.

This book is designed for those who are interested in flying. By means of diagrams and descriptions, various common aviation terms are defined. The words are arranged alphabetically starting with amphibian and ending with zeppelin. The book is well illustrated. —G.S.C.

REED, W. MAXWELL. *The Stars for Sam.* New York: Harcourt, Brace and Company, 1931. 190 p. $3.00.

This volume has been enthusiastically received by many children. It covers a content that has always excited the curiosity of people of all ages. The book is well illustrated. —G.S.C.

REED, W. MAXWELL. *The Earth for Sam.* New York: Harcourt, Brace and Company, 1930. 390 p. $3.50.

This book has proved to be an interesting presentation of the earth and earth history for children of the intermediate and junior high school grades. It is designed as a text book but may serve for supplementary reading. It deals with earth formation and the various geological periods. Many of the diagrams are fanciful in nature, designed to amuse the reader.

The book deals with the changing earth and the forces which have produced those changes. and the succession of life through the ages. —G.S.C.

BOWMAN, ISAIAH. *The Pioneer Fringe.* New York: American Geographical Society, 1931. 361 p. $4.00.

To many the term "Pioneer Days" refers to a time long since past, a time of brave men and brave women, Indian fights, the Oregon Trail and the covered wagon. Time has slowly erased the memories of bitter tears and heart-breaking failures and to many it has become a time of romance, the golden age of American opportunity, when land could be had for the asking. In those days man preferred freedom to comfort. Rough fare and homespun were accepted as a part of the price for economic and social independence.

How different is pioneering today as Bowman points out in *The Pioneer Fringe.* Homespun and rough fare are no longer acceptable to those who "pioneer." Nowadays even a pioneer wants to have—to be able to produce and have. Pioneer lands of today are of great extent. Every continent in the world has vast lands open for settlement. Some of the land is of the very best soil—much is almost valueless. The United States has 200,000,000 acres open for homesteading and Alaska has an additional 350,000,000 acres—an amount far larger than most of us would have guessed.

The book describes many of the pioneer lands of today. Part I discusses: "Pioneering;" "Modern Style;" "Does It Pay?;" "The Invitation of the Land;" "Metes and Bounds;" "Railways as Pioneers;" "Science Plays a Part." Regional examples selected from each of the continents are described in Part II. There are approximately 200 excellent photographs.

It is a book that laymen will find both delightful reading and, at the same time, quite informational. It is especially recommended to teachers of geography.

—C. M. P.

Ditmars, Raymond L. *Thrills of a Naturalist's Quest.* New York: The Macmillan Company, 1932. 268 p. $3.50.

To those who have read and thrilled over Ditmars' *Strange Animals I Have Known* this new book will prove to be a thrilling sequel. The title is an apt one. Few writers can equal, and none excell, the author's ability to describe the interesting experiences that fall to the lot of the average naturalist. But then it is really a misnomer to call Ditmars an "average" naturalist for he is certainly more than that. He is the greatest authority in the world on reptiles and in this book he describes many experiences with the fer-de-lance, king cobras, rattlesnakes, boa constrictors, pythons and bushmasters. Certainly the "average" naturalist does not go about over the world seeking these in order that he may become their caretaker and health inspector!

Not only does the author describe his experiences in capturing reptiles and the methods of caring for them in the zoo, but also he relates his experiences in becoming an "animal man" caring for aard-varks, armadillos, ant-eaters, echnidnas, kinkajous, koalos, elephants, lions, tigers, monkeys, and the like.

What unusual schools have been those in which Ditmars received his training! They were a combination of technical academy, the circus, the jungle, scientific museums, and rows of populous cages in his home.

This is a book that every boy, and most girls, too, will enjoy. It is recommended to biology students and teachers, and to everyone interested in an unusual portrayal of animals both in their native haunts and in the zoo. —C. M. P.

Cheesman, Evelyn. *The Growth of Living Things.* New York: Robert M. McBride and Company, 1932. 192 p. $2.00.

The ways and means by which sex education may be introduced naturally into the lives of boys and girls has always been a moot question. Just how, when, and how far one may or should go in discussion of sex questions has long vexed those who believe much could be accomplished in directing the thought life of boys and girls along these lines, if only the proper approach could be tactfully made. *The Growth of Living Things* does this important work with delicacy and accuracy.

News and announcements

The Boston Meeting of the Committee on the Place of Science in Education

At the Chicago meeting of the American Association for the Advancement of Science, the Council took action instructing the A.A.A.S. Committeee on the Place of Science in Education to organize a one-day program for those interested in science teaching. This program will be presented in Boston during the winter meetings of the A.A.A.S. and will probably be on Friday, December 29, 1933. Delegates and individual members from all science teachers organizations throughout the country are invited to attend this meeting. All science teachers organizations interested in being represented at the Boston meeting, or individuals who may wish to attend, may secure further information regarding the program by writing to the Committee on the Place of Science in Education, American Association for the Advancement of Science, Smithsonian Institution Building, Washington, D.C. It is expected that the program will be printed in magazines during the autumn.

This program is being organized as a result of various suggestions concerning a national federation of science teachers. The program will be arranged by the Committee on Place of Science in Education, though that committee has no recommendations to make concerning the federation.

Joint Offerings in Science at Peabody College for Teachers

Three instructors of content science at George Peabody College for Teachers are pooling their time and experience in the offering of two broadly organized courses in which they will participate to some extent during each quarter. Dr. Claude R. Fountain of the Department of Physics, Dr. Jesse M. Shaver of the Department of Biology, and Dr. Hanor A. Webb of the Department of Chemistry and General Science have outlined the topics in conference and will present them for the first time in the regular year of 1933–1934. One course on the Junior College level is of an elementary nature; the other is of sufficient advancement that graduate credit may be gained from its successful completion. Each course involves demonstration and laboratory work, as well as considerable study of references.

The titles and description of the courses are as follows:

General Science 100A. General Science—Content and Method. Fall quarter, 2 hours credit, Mr. Webb, Mr. Fountain, Mr. Shaver.—The first of a series of courses for teachers of elementary and general science, and for those who desire cultural values. It presents the structure of the earth and its crust; vulcanism; structure and composition of rocks; the ocean; trees and forestry; atmosphere phenomena; causes and effects of weather; introductory star study; the soil, its formation, composition, and conservation; useful minerals and ores; building materials.

General Science 100B. General Science—Content and Method. Winter quarter, 2 hours credit, Mr. Fountain, Mr. Shaver, Mr. Webb.—A continuation of 100A, presenting the sun and its family, the magnitude of the universe, the nature and properties of matter and energy; chemicals in the home; common diseases; simple machines; musical instruments; heating and lighting in the home; engines and motors; X-rays and radium.

General Science 100C. General Science—Content and Method. Spring quarter, 2 hours credit, Mr. Shaver, Mr. Webb, Mr. Fountain.—A continuation of 100A and 100B. Representative topics are birds—their identification, habits, and value to man; wild flowers; insects, especially those of importance to man; trees and forests; the conservation of natural resources; foods and their selection; diseases, especially as related to bacteria and human parasites; summer constellations.

General Science 400A. A Survey of Science. Fall quarter, 4 hours credit. Mr. Fountain, Mr. Webb, Mr. Shaver.—The first of a series of survey courses for science majors in their senior year, and graduate students who need to broaden their scientific perspective and content. The principal topics include a brief historical survey of the principal sciences; their mutual relationships and their relations to the progress of civilization; the physical laws developed from astronomical observations; the origin of astronomical bodies; the expansion of astronomical facts with new physical instruments; the rapid development in the various sciences with the adoption of experimental methods; the bearing of the concept of the conservation of energy upon progress in the various sciences; the application of the concepts of energy, radiation, and atomic structures upon the progress of industries and modern civilization.

General Science 400B. A Survey of Science. Winter quarter, 4 hours credit, Mr. Webb, Mr. Shaver, Mr. Fountain.—A continuation of 400A, with emphasis on the broad principles of geology, meteorology, oceanography; the history of chemistry and of medicine; chemical phenomena manifested in minerals, the soil, plant and animal tissues; the materials of civilization.

General Science 400C. A Survey of Science. Spring quarter, 4 hours credit, Mr. Shaver, Mr. Fountain, Mr. Webb.—This course continues the rapid survey of science presented in 400A and 400B. Representative topics are the nature and origin of life; bacteria; development of the plant kingdom; development of the animal kingdom; pre-historic man; human inheritance; human physiology; man's relation to his environment.

The International Organization of Chemical Documentation

Questions concerning documentation have of late assumed more and more importance. Scientific and technical documents increase on all sides in such numbers that it becomes more and more difficult to gather useful material for the benefit of inquirers. There are many bodies that deal permanently with the registering, classing and diffusion of such documents. Now the coördination of the respective activities of these institutions on an international basis has become neeessary in order to permit them to carry on their work efficiently.

As regards the province of chemistry a step was taken in 1932, in the scientific and technical sphere, by the entry into activity of the INTERNATIONAL OFFICE OF CHEMISTRY, created by international convention, and having its headquarters in Paris.

Its first act was the summoning of a Conference of Experts, which included the following personalities: Messrs. F. Donker Duyvis, Member of the Council of Patents, The Hague; P. Dutoit, Professor at the University of Lausanne; F. Haber, Director of the Kaiser-Wilhelm Institut für Physikalische Chemie und Electrochemie, Berlin; E. Hauser, Member of the Academy of Sciences, Madrid; Ch. Marie, Secretary General of the Comité International des Tables Annuelles de Constantes, Paris; N. Parravano, Member of the Academy of Italy, President of the Comitato Nazionale di Chimica, Rome; G. Peny, President of the Federation of Chemical Industries of

Belgium, at Brussels; J. C. Philip, Professor at the Imperial College of Science and Technology, London.

The work of this Conference of experts led to the adoption of a certain number of recommendations fixing the three principal tasks of the Office:

I. To render accessible to all interested persons the already existing documentation, accumulated in the various centres, depots and collections.

II. To guide the chemical documentation which is in course of production, in such a way as to facilitate its registering, filing and diffusion, by methods found to be the best.

III. To ensure coördination between the documentation relative to chemistry and that concerning other scientific knowledge in the field of international documentation.

Thanks to these varied operations, the users of such documentation will find that all over the world a practical and rational organization of documentation in chemistry is being carried out systematically and progressively, liable to be more and more effectively adapted to their needs.

Activities of the Hebrew University in Palestine

The League of Nations will again subsidize for the forthcoming year the Malaria Research Station of the Hebrew University in Jerusalem, according to an announcement made yesterday by Dr. A. S. W. Rosenbach, President of the American Friends of the Hebrew University, located at 71 West 47th Street, New York City. Dr. Yao, chief of the Malaria Division of Nanking, China, has been in Palestine for several weeks, studying the problem of malaria and its control at the University Station in Rosh-Pinah and other places in the country. The University Malaria Research Station is at the great Huleh Swamp, the largest in the world. The League has selected the Hebrew University as one of six institutions throughout the world to carry on malaria research.

A grant of £1,000 by the Palestine Economic Corporation of New York City, Dr. Rosenbach announced, will enable the Hebrew University to install a Materials Testing Laboratory. The entire machinery has been ordered from Switzerland, and is to be installed within the near future. The Materials Testing Laboratory will form part of the Einstein Physics Institute, the gift of the late Philip Wattenberg and Solomon and Dora Moness Shapiro of New York.

Additional gifts to the Physics Institute for spectoscopical research were also announced by Dr. Rosenbach. Mr. Harry Sacher, of London, acting for the Marks-Sacher-Sieff families of London, has presented £500 for new equipment for the Department of Physics. Mr. Sacher has also donated £200 for research in poultry diseases now being conducted by the Department of Parasitology at the Hebrew University.

Personals

Professor S. Ralph Powers of Teachers College, Columbia University, lectured for the first two weeks of the summer session at the State Teachers College in Greeley, Colorado. A reorganization of the work at Greeley has resulted in bringing all of the work in science under one head. It has resulted in the extension of responsibilities for instruction in science from the department of natural science into each of the administrative divisions of the schools affiliated with the College. The members of the science department and the officers of administration have developed a most effective plan for work in this field.

Professor E. Laurence Palmer of Cornell University lectured at Iowa State College during the recent summer session. Two days of his stay in the West were devoted to talks on Science Teaching at the summer session of the University of Nebraska.

Dr. Philip G. Johnson, who has completed his work for the doctorate at Cornell University has returned to the University of Nebraska, after an absence of two years. He taught courses in science education in the summer session, and will supervise the teacher-training-in-science subjects during the coming year in Teachers College of the University of Nebraska.